The Wind Erosion Prediction System

WEPS 1.0

User Manual DRAFT

USDA-ARS
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Preface and Acknowledgments

Preface

Wind erosion is a serious problem on agricultural lands throughout the United States as well as the world. The ability to accurately predict soil loss by wind is essential for, among other things, conservation planning, natural resource inventories, and reducing air pollution from wind blown sources. The Wind Erosion Equation (WEQ) is currently widely used for assessing average annual soil loss by wind from agricultural fields. The primary user of WEQ is the United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). When WEQ was developed more than 35 years ago, it was necessary to make it a simple mathematical expression, readily solvable with the computational tools available. Since its inception, there have been a number of efforts to improve the accuracy, ease of application, and range of WEQ. Despite these efforts, the structure of WEQ precludes adaptation to many problems.

The USDA appointed a team of scientists to take a leading role in combining the latest wind erosion science and technology with databases and computers, to develop what should be a significant advancement in wind erosion prediction technology. The Wind Erosion Prediction System (WEPS) incorporates this new technology and is designed to be a replacement for WEQ.

Unlike WEQ, WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, management, and erosion. WEPS 1.0 consists of the WEPS science model with a user friendly interface that has the capability of simulating spatial and temporal variability of field conditions and soil loss/deposition within a field. WEPS 1.0 can also simulate simple field shapes and barriers on the field boundaries. The saltation/creep, suspension, and PM10 components of eroding material also can be reported separately by direction in WEPS 1.0. WEPS 1.0 is designed to be used under a wide range of conditions in the U.S. and is adaptable to other parts of the world. For further information regarding WEPS contact:

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Acknowledgments

The Wind Erosion Prediction System (WEPS) resulted from the work of many individuals representing several agencies and institutions. In particular, appreciation is extended to the WEPS Core Team members:, D.V Armbrust (retired), J.D. Bilbro (retired), G.W. Cole (retired), A.A. Durar, F. Fox, D.W. Fryrear (retired), R.B. Grossman, L.J. Hagen, L. Lyles (retired), A. Retta, A. Saleh, H.H. Schomberg, H.R. Sinclair, E.L. Skidmore, J.L. Steiner, J. Tatarko, P.W. Unger (retired), S. Van Donk, and T.M. Zobeck; the Agency liaisons to the Core Team, including: M.S. Argabright, NRCS (retired), H. Bogusch, NRCS, R. Dunkins, EPA, and C. Voight, BLM; the ARS NPL including: C.R. Amerman (retired), S. Rawlins (retired), W.D. Kemper (retired), and Mark Weltz; and NRCS leaders including K. Flach (retired), D. Schertz (retired), G.L.Tibke, and D. Woodward.

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The contribution of the NRCS state and field offices and other individuals who participated in the WEPS validation studies is also recognized.

Finally, acknowledgment is made of the many other individuals who have made this release of WEPS possible by reviewing this document and those who contributed through fundamental research on which many of the underlying concepts of WEPS are based.

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INTRODUCTION

Introduction

How to Use This Document

The Wind Erosion Prediction System or 'WEPS' is a process based, daily time-step, wind erosion simulation model. It represents the latest in wind erosion prediction technology and is designed to provide wind erosion soil loss estimates from cultivated, agricultural fields. WEPS 1.0 consists of the computer implementation of the WEPS science model with a graphical user interface designed to provide easy to use methods of entering inputs to the model and obtaining output reports. WEPS was developed by the Wind Erosion Research Unit (WERU) of the United States Department of Agriculture, Agricultural Research Service.

The WEPS 1.0 User Manual is designed to provide information to different levels of users. Those users who are completely new to WEPS should start by reading all of this chapter to get an introduction to WEPS. It is recommended that, as a minimum preparation to use WEPS, the user should read the "Overview of the Wind Erosion Prediction System".

The minimum computer requirements and the steps to install WEPS onto your computer are described in this chapter. Once WEPS has been installed on your computer, the user should learn how to make a simple simulation run using the "Quick Start for WEPS 1.0". More experienced users should become familiar with the "Interface Reference - How to Operate WEPS", which goes into detail of how to use all of the capabilities of WEPS 1.0. These details are also available in the 'Online Help', accessible through the toolbars on the WEPS 1.0 interface screen.

"Using WEPS in Conservation Planning" contains sections on 'Interpreting Outputs', 'Special Field Configurations', and 'Using Barriers for Erosion Control in WEPS'. This section also has Example problems which guides the user through exercises that describe how to use WEPS to design conservation systems.

An index to the WEPS User Manual is also available. Finally, the "Appendices" contains information for more advanced users. For users interested in more details of the science behind WEPS, the appendix titled "Science - How WEPS Simulates Wind Erosion" is recommended. An even more detailed description of the science of the WEPS model is available in the "WEPS Technical Description" which can be obtained from WERU.

The Appendix also contains information for more advanced users such as the WEPS 'Databases' and a listing of 'Submodel Report Flags and Command Line Options'. Databases are described for the Weather, Soil, Crop, Management, and Operations sections of WEPS. Submodel Report Flags and Command Line Options are set under the

'Configurations' tabs available through the Main Screen of the interface. Certain permissions may be required to alter some of these flags and options. There is an appendix on "Using WEPS with Measured Data" which will be useful to researchers and other users such as those outside the US who do not have their soils data in the SSURGO database format.

Throughout this manual, the term "user" refers to the person(s) using WEPS 1.0 to set up and make a simulation run. "Operator" refers to the producer or land manager whose actual field is being simulated with WEPS. This manual contains many graphics which are examples of what can be seen on the computer screen using WEPS. In addition, WEPS will continually be improved and the screens may change. Therefore, the user may or may not see the exact same screens as those illustrated in this manual.

WEPS is a model developed primarily for use by the USDA, Natural Resources Conservation Service (NRCS). As such, many of the capabilities of WEPS reflect the needs of NRCS for use in cultivated agricultural systems. However, WEPS has capabilities to be used in other situations where wind affected soil movement is a problem. Please contact WERU if you wish to use WEPS to predict erosion for situations other than traditional cultivated agricultural systems.

Minimum Computer Requirements

The minimum recommended requirements to install and operate WEPS 1.0 effectively are: A personal computer (PC) with Windows 95/98 (48 Mb RAM), Windows NT (64 Mb RAM), Windows 2000 (192 Mb RAM), or Windows XP (256 Mb RAM); 300 MHz Pentium; 150 Mb free disk space on the hard drive; a CD-ROM drive for installation; and a VGA color monitor with a minimum screen resolution if 800 x 600 pixels. Contact WERU if you need assistance.

Installation

For Windows operating systems, insert the WEPS 1.0 CD into the CD-ROM drive. Click [Start] [Run] and enter {w:/setup} where "w" represents the drive letter for your CD-ROM drive. Follow the instructions on the screen. NOTE: See the "readme" file for up-to-date installation instructions for this CD-ROM. Note that on Windows NT, 2000, and XP machines, the user must either be logged in as "administrator" or have sufficient privileges to successfully install WEPS 1.0. The WEPS install program will inform the user attempting installation if they do not have sufficient privileges to perform the installation.

WEPS1.0 is also available for download on the WERU web site at http://www.weru.ksu.edu/weps . Follow the link for the WEPS download and fill out the WEPS Download Registration form. By filling out the registration form, WERU will provide notices of updates to the model. The download file consists of an executable file which will install WEPS onto your Windows computer. Contact WERU if you need assistance at:

Phone: 785-537-5559
E-mail: weps@weru.ksu.edu .

An Overview of the Wind Erosion Prediction System

Introduction

The Wind Erosion Prediction System (WEPS) is a process-based, daily time-step model that simulates weather, field conditions, and erosion. WEPS development was in response to customer requests for improved wind erosion technology. It is intended to replace the predominately empirical Wind Erosion Equation (WEQ) (Woodruff and Siddoway, 1965) as a prediction tool for those who plan soil conservation systems, conduct environmental planning, or assess offsite impacts caused by wind erosion.

WEPS development involves an ARS led, national, multi-disciplinary team of scientists. It has a multi-agency commitment consisting of the Agricultural Research Service (ARS), Natural Resource Conservation Service (NRCS), and Forest Service (FS) from the U.S. Department of Agriculture, along with the Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers, and Bureau of Land Management (BLM).

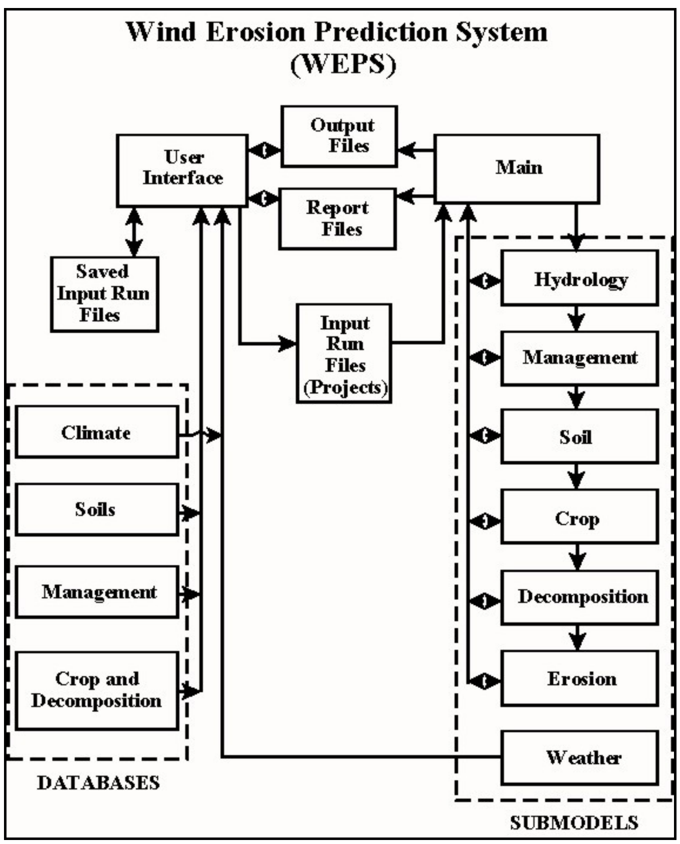

Figure 1.1. Structure of the WEPS model.

Objectives

The purposes of WEPS are to improve assessment of soil loss by wind from agricultural fields and to provide new capabilities such as assessing plant damage, calculating suspension loss, and estimating PM-10 emissions from the field.

Background

Soil erosion by wind is initiated when the wind speed exceeds the saltation threshold speed for a given soil and biomass condition. After initiation, the duration and severity of an erosion event depend on the wind speed and the evolution of the surface condition. Because WEPS is a continuous, daily time-step model, it simulates not only the basic wind erosion processes, but also the processes that modify a soil's susceptibility to wind erosion.

The structure of WEPS is modular and consists of a user-interface, a MAIN (supervisory) routine, seven submodels, and four databases (Fig. 1.1). The user-interface is used to create input files with information from the databases and the weather generator. In a practical application, new input files usually will be created by using previous input files as templates modified within the user-interface.

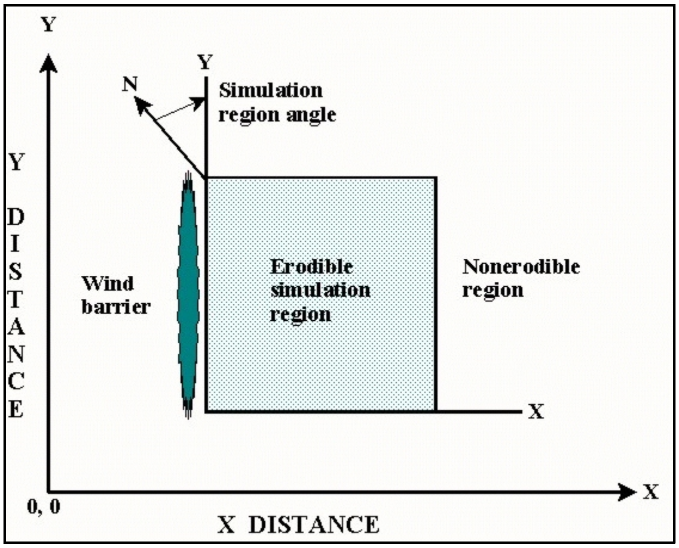

Figure 1.2. WEPS simulation geometries.

Simulation Region
In WEPS, the simulation region is a field (Fig. 1.2). Users must input the geometry of the simulation region. Initial conditions must also be specified for the surface and soil layers. WEPS can output soil loss/deposition over selected time intervals from the simulation region. WEPS also provides users with individual soil loss components of creep-saltation, suspension, and PM-10 size fractions. The soil loss components are particularly useful as an aid in estimating off-site impacts of wind erosion.

Discrete Time and Space
The time step is controlled within the main program. To reduce computation time, a daily time step is used in WEPS, except for selected subroutines in the HYDROLOGY and EROSION submodels, which use hourly or sub-hourly time steps. Submodels are called by the MAIN program (Tatarko, 1995) in the order shown in Fig. 1.1. Each individual submodel controls the sequence of calculations within itself. However, in MANAGEMENT, field operations are simulated sequentially according to the order in which they appear in the management plan. Management plans usually cover at least a single year and may cover multiple years. WEPS simulates conditions and soil loss on homogeneous simulation regions. "Homogeneous" means that the soil type, biomass, and management are similar over a subregion.

Weather Simulated from Climate Databases
WEPS requires wind speed and direction to simulate the process of soil erosion by wind. These and other weather variables are needed to drive temporal changes in hydrology, soil erodibility, crop growth, and residue decomposition in WEPS. The weather generator consists of the programs WINDGEN and CLIGEN (Tatarko et al., 1995).

WINDGEN simulates wind speed and direction for WEPS (Skidmore and Tatarko, 1990; Wagner et al., 1992). It was developed specifically for use with WEPS and stochastically simulates wind direction and sub-daily wind speeds. A compact database (Skidmore and Tatarko, 1990, 1991) developed for WINDGEN was derived from historical monthly summaries of wind speed and wind direction contained in the Wind Energy Resource Information System (WERIS) database at the National Climatic Data Center in Asheville, North Carolina.

CLIGEN is the weather generator developed for the Water Erosion Prediction Project (WEPP) erosion model (Nicks et al., 1987). It is used with WEPS to generate an average annual air temperature as well as daily precipitation, maximum and minimum temperatures, solar radiation, and dew point temperature. Average daily air temperature and elevation for the site are used to calculate average daily air density within WEPS. CLIGEN and its database are described fully in the WEPP documentation (Nicks and Lane, 1989).

Field Conditions Simulated

The HYDROLOGY submodel (Durar and Skidmore, 1995) estimates soil surface wetness; accounts for changes in soil temperature; and maintains a soil-water balance based on daily amounts of snow melt, runoff, infiltration, deep percolation, soil evaporation, and plant transpiration. Snow melt depends on maximum daily air temperature and initial snow water content. Runoff is calculated from rainfall rate greater than infiltration, adjusted for ponding and surface flow velocity. Water is infiltrated and distributed according to Darcy's Law. Potential evapotranspiration is calculated using a revised combination method of Van Bavel. Total daily potential evapotranspiration then is partitioned, based on crop leaf area index, into potential soil evaporation and plant transpiration. Hourly potential soil evaporation rates are estimated from the daily value based on soil water availability.

A soil's aggregation and surface state can dramatically affect susceptibility to wind erosion. Thus, changes in soil and surface temporal properties are simulated daily by the WEPS SOIL submodel (Hagen et al., 1995b) in response to various weather processes like wetting/drying, freeze/drying, freeze/thawing, precipitation amount and intensity, and time. Soil layer properties such as bulk density, aggregate size distribution, and dry aggregate density are maintained on a daily basis. Surface properties, such as random and oriented roughness; crust generation, coverage fraction, density, stability, and thickness; and loose erodible material on crusted surfaces also are accounted for in the SOIL submodel.

The presence of live biomass on the soil surface influences the quantity of soil that can be removed by wind erosion. Therefore, the CROP submodel (Retta and Armbrust, 1995) simulates the growth of crop plants. The crop growth model was adapted from the Erosion Productivity Calculator (EPIC) crop growth model (Williams et al., 1990), which simulates a variety of crops and plant communities while accounting for water stresses. It calculates daily production of masses of roots, leaves, stems, and reproductive organs and also leaf and stem areas. Additional capabilities and modifications have been incorporated into the CROP submodel to meet the need for predicting effects of a growing crop on wind erosion. Some of the factors that affect wind erosion are the flexibility and arrangement of individual plant parts, distribution of plant parts by height, and number of plants per unit area (Shaw and Periera, 1982). Thus, leaves and stems are accounted for separately because: 1) stems of young seedlings are roughly 10 times more effective than leaves, on a per-unit-area basis, in depleting wind energy; 2) leaves are more sensitive to sandblast damage than are stems; and 3) decomposition rates of stems and leaves are different.

The DECOMPOSITION submodel (Steiner et al., 1995) for WEPS simulates the decrease in crop residue biomass from microbial activity. The decomposition process is modeled as a first order reaction, with temperature and moisture as driving variables. Standing residue is significantly more effective than flat residue at reducing wind energy at the soil surface. Hence, it is maintained separately from flat residue, and the conversion from standing to flat is simulated. The quantities of biomass remaining after harvest are partitioned into standing, surface, buried, and root pools with below ground biomass decomposition calculated for each soil layer. Because crop residue decomposition varies by type and changes with residue age, each pool is subdivided further into 1) the most recently harvested crop pool, 2) the penultimate crop pool, and 3) a "generic" crop pool that contains all older residue mass.

WEPS is expected to reflect the effects of various management practices upon wind erosion, and that is done by the MANAGEMENT submodel (Wagner and Ding, 1995). All major management operation classes are represented, such as primary and secondary tillage, cultivation, planting/seeding, harvesting, irrigation, fertilization, and burning. Each individual operation is simulated within the MANAGEMENT submodel as a series of physical processes. Those processes include 1) soil mass manipulation (changes in aggregate size distribution, soil porosity, mixing soil and residue by depth, and soil layer inversion); 2) surface modification (creation or destruction of ridges and/or dikes that form oriented surface roughness, changes in surface random roughness, and destruction of surface crusts); 3) biomass manipulation (burying and resurfacing residue, cutting standing residue, flattening standing residue, killing live crop biomass, and biomass removal); and 4) soil amendments (residue addition, planting, and irrigation).

Erosion Processes Simulated

The EROSION submodel (Hagen, 1995) decides if erosion can occur based on the current soil surface roughness (oriented and random), flat and standing biomass, aggregate size distribution, crust and rock cover, loose erodible material on a crust, and soil surface wetness. If the maximum daily wind speed reaches 8 m/s at 10m and snow depth is less than 20mm, the surface condition is evaluated on a sub-hourly basis to determine if erosion can occur. The EROSION submodel simulation performs the following functions: 1) calculates friction velocities based on the aerodynamic roughness of the surface, 2) calculates static threshold friction velocities, 3) computes soil loss/deposition within each grid cell, and 4) updates soil surface variables to reflect changes in soil surface "state" caused by erosion.

Summary Comparison of WEPS and WEQ

Users of wind erosion prediction technology encounter a wide range of challenging environmental problems that require solutions. WEQ was unable to meet some of these needs. After extensive consultations with users, the WEPS structure was designed with the capabilities to meet the needs identified. As such, WEPS represents new technology and is not merely an improvement and recoding of WEQ technology. Also, WEPS contains many simplifications to maintain reasonable computation times. Because many users are familiar with WEQ, a brief comparison of WEPS and WEQ follows to facilitate understanding of WEPS modeling techniques.

WEQ predicts average erosion along line-transects across the field, whereas WEPS treats the field as two-dimensional. The WEPS EROSION submodel simulates soil loss/deposition for grid areas over the entire simulation region. This feature allows users to "look inside" by specifying arbitrary accounting regions within the simulation region and, thus, obtain results averaged over selected grid areas within the accounting region (not available in WEPS 1.0).

WEQ predicts only long-term, average, soil loss. WEPS calculates on a daily basis and allows users to specify the output intervals. Thus, users can obtain outputs ranging from single storms to multiple years. By simulating for multiple years, the probability of various levels of erosion during any period of a rotation also can be determined.

The largest contrast between the two technologies is that WEPS simulates a wide range of processes to describe field surface conditions and wind erosion, whereas WEQ depends on users to input correct estimates of the field surface conditions. Unfortunately, erosion does not vary linearly with residue cover and other temporal field conditions. Therefore, simply specifying average field conditions as inputs likely will not yield the best estimates of long-term average erosion.

The WEQ contains no feedback loop that modifies the field in response to weather or erosion. In WEPS, the driving forces of weather cause surface temporal properties of the field to change. Thus, in a year with high rainfall, the field soil roughness may be reduced below average, while above average biomass production prevents erosion. However, in a drought year, biomass and aggregate size may both be below average, but tillage ridges may then be the primary control against soil erosion.

The modeling techniques used to simulate processes in WEPS vary. The WEATHER submodel generates stochastic simulated weather variables. Mechanistic and statistical relations are used to represent processes in the other submodels. However, a structured design methodology was used. First, the major wind erosion processes, such as emission, abrasion, and trapping were identified. Next, the individual temporal soil and biomass properties that affect the wind erosion processes were selected. Then, WEPS submodels were designed to simulate the general processes that control both the surface temporal properties and the erosion processes. Finally, parameters from the databases were used to make the simulation of various processes unique for specific soil, crop, and management actions.

Implementation
The current WEPS model is coded in FORTRAN conforming to the ANSI FORTRAN 77 and Fortran 95 standard. The coding guidelines used, with some minor modifications for WEPS, are outlined in the "Water Erosion Prediction Project (WEPP) Fortran-77 Coding Convention" (Carey et al., 1989). The model can be run in a Windows, Unix, or Linux environment. WEPS science code and implementation is documented fully in the WEPS Technical Description (Hagen et al., 1995a).

WEPS Updates
The WEPS model is continually being improved with periodic updates. The USDA-ARS Wind Erosion Research Unit (WERU) has established several means for obtaining the latest release of the WEPS model, databases, documents, and other related information as they become available.

For users with Internet access, WERU has established a World Wide Web site. The URL for WEPS downloads is: *http://weru.ksu.edu/weps*. This site contains all the information on WEPS. Specific WEPS information also can be obtained through E-Mail at: *weps@weru.ksu.edu* .

Users without Internet access can obtain WEPS update information by contacting:

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Quick Start for WEPS 1.0

WEPS is a comprehensive wind erosion model with many options for inputs and outputs. However, for basic simulations, WEPS is simple to operate. The following quick start guide will describe how to make a simple simulation run.

To start WEPS, double left click on the Weps1.0 icon on the computer screen 'desktop' . Note: the NRCS standard is to start WEPS from the 'Start Menu' (e.g., "Start>Programs>USDA Applications>WEPS>WEPS 1.0"). The WEPS 1.0 main screen will then appear.

A Simple Simulation

For a simple simulation, only four types of information are entered on the main screen.

1. Describe the simulation field geometry by selecting the field dimensions and field orientation in the panel labeled "Simulation Region Information".
   a. Type in the specific X-Length and Y-Length field dimensions.
   b. Enter the specific field orientation (±45° max) relative to true north, in the "Orientation" box.

2. Select a field location (for weather files).
   a. In the panel labeled "Location Information", use the mouse to select a State and County from the drop down menus . The closest weather stations to the center of the selected county will be loaded.

3. Select a soil.
   a. In the bottom panel of the window, to the right of the button labeled 'Soil', use the mouse to select a soil from the drop down "Template" menu .

4. Select a management scenario.
   a. In the bottom panel of the window labeled 'MCREW', use the mouse to select a crop rotation from the drop down "Template" menu .

Once these items are complete, click the 'Run' button on the tool bar at the top of the screen. You will be asked to enter a name for the simulation run and click 'OK'. Once a run name is entered, you will then see indicators that WEPS 1.0 is running. When the simulation run is finished, the "WEPS Project Summary" screen will appear.

WEPS Project Summary

The Project Summary displays user information, input parameter files, and basic soil loss information by rotation year and the average annual for the total simulation. Soil loss output in the Project Summary includes: ***Gross Loss*** which is the average erosion within the field; ***Total*** which is the average total net loss from the field; ***Creep/Salt*** which is the average creep plus saltation net loss from the field; ***Suspension*** which is the average suspension net loss from the field; and ***PM10*** which is the average net loss of particulate mater less than 10 microns in size from the field.

Exiting WEPS 1.0

To exit WEPS 1.0, click "Project" on the menu bar at the top of the main screen, then click "Exit". You will be asked if you want to save your project. You will also be asked to confirm if you really want to exit WEPS 1.0.

Additional Information

WEPS has the capability for many simulation input options including adding barriers, and specifying numerous management options. WEPS also can optionally produce very detailed output to provide the user with a better understanding of what field conditions and management situations cause soil loss by wind. Consult the WEPS 1.0 User Manual for complete details. For further information regarding WEPS contact:

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Web: http://www.weru.ksu.edu/weps

INTERFACE REFERENCE

WEPS Interface Main Screen

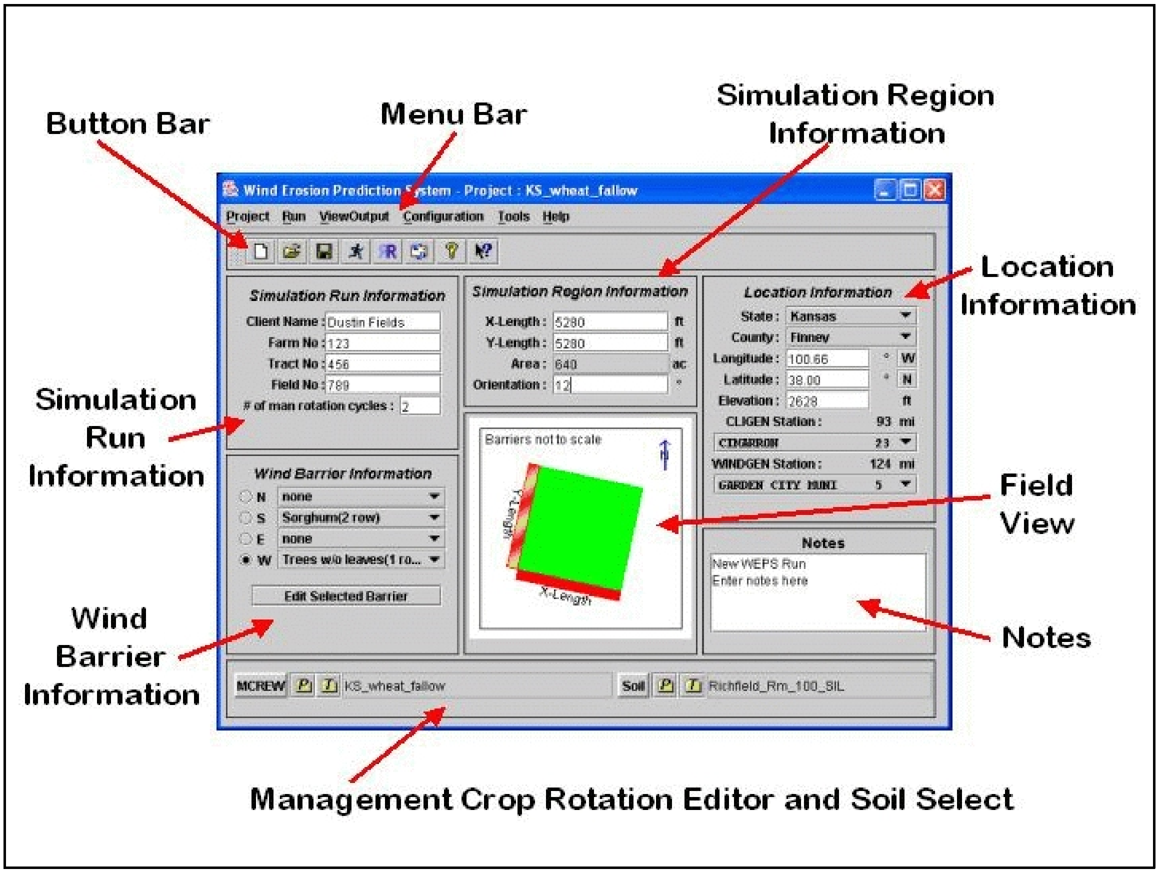


Figure 2.1. Main screen of the Wind Erosion Prediction System.

This is the WEPS main screen (Fig. 2.1) which should appear at the model startup. Each part of the main screen is labeled with regard to its function. A brief description of each part is given below. More detailed descriptions of their functions and use follow later in this chapter.

- The **Button Bar** and **Menu Bar** are collectively referred to as Toolbars. The Menu Bar provides the user with access to many of the operational functions of WEPS. The Button Bar provides a shortcut way of executing some of the Menu Bar functions.

- The **Simulation Run Information** panel is used to enter customer information for a simulation run as well as the run length. The customer information is for information only and is not critical to the operation of WEPS.

- The **Simulation Region Information** panel provides the physical dimensions (i.e., length and width) as well as the orientation of the simulation field.

- The **Location Information** panel is used to enter the location of the simulation field. This information is used to determine the climate and wind for the simulation.

- The properties and placement of barriers on the field borders is entered in the **Wind Barrier Information** panel.

- The **Field View Panel** displays the physical dimensions and orientations of the field and barriers. This panel is for information only and is not editable.

- User **Notes** can be entered in the lower right of the screen. These notes are retained as part of the project and are printed on the Output Summary.

- Access to the **Management Crop Rotation Editor** for WEPS (MCREW) allows for the selection, creation and editing of management scenarios.

- The **Soil** panel is used to select and view the soil information for the simulation. Only one soil is allowed for the WEPS simulation region.

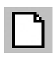
Toolbars

Menu Bar

This is the top line of the WEPS main screen. A description of each item on the menu bar is given below.

Project

The '**Project**' menu brings up a drop down list of various operations pertaining to WEPS projects. The Project menu contains the following options:

-  **New** - allows user to create a new project from scratch (Ctrl-N).
-  **Open...** - opens an existing project (Ctrl-O).
-  **Save** - saves the currently displayed project to its current file name (Ctrl-S).
- **Save As...** - saves currently displayed project.
- **Exit** - exit the WEPS program (Ctrl-X).

Run

This allows the user to run WEPS using the current project or restore other projects. The '**Run**' menu on the WEPS Main Screen brings up the following options:

- '**Make a WEPS Run**' - begin a simulation.
- '**Make a Yield Calibration WEPS Run**' - begins a simulation un of WEPS in yield calibration mode.
- '**Restore a WEPS Run**' - restores a previously loaded WEPS project.

ViewOutput

This menu allows the user to view output for the current and previous runs.

- '**Current Run**' - clicking on this menu item opens a list of output options.
  - '**Project Summary'** - open a brief output summary for the current project (Ctrl+Shift-P).
  - '**Crop Summary**' - open a summary of yield parameters for the current project (Ctrl+Shift-Y).
  - '**Management Summary**' - open a summary of management operations for the current project (Ctrl+Shift-M).

- '**Detailed Reports**' - open a detailed output for the current run (Ctrl+Shift-R).
- '**Raw Output**' - open the raw output file used to create the detailed reports (Ctrl+Shift-O).

‣ '**Previous Run**' - clicking on this menu item opens the following list of output options.

- '**Project Summary**' - open a brief output summary of a previous run project (Ctrl+Alt-P).
- '**Crop Summary**' - open a summary of yield parameters for a previous run project (Ctrl+Alt-Y).
- '**Management Summary**' - open a summary of management operations for a previous run project (Ctrl+Alt-M).
- '**Detailed Reports**' - open the detailed output for a previous run project (Ctrl+Alt-R).
- '**Raw Output**' - open the raw output file used to create the detailed report for a previous run project (Ctrl+Alt-O).

Configuration

The '**Configuration**' menu currently has only one item, '**Edit Configuration**' which brings up a tabbed window with various configuration options for WEPS.

‣ '**Miscellaneous**' - opens a tab that allows the user to set the following:

- Display either Metric or English units on WEPS screens.
- Enter the number of time steps used for the daily distribution of simulated wind speed.
- Check box to display the latitude and longitude fields in the '**Location Information'** panel on the Main screen. Un-check the box to hide these fields.
- Check box to display the state and county fields in the '**Location Information'** panel on the Main screen. Un-check the box to hide these fields.
- Check box to display the '**Use Map**' button in the '**Location Information**' panel on the Main screen. Un-checking the box, hides this button.
- Maximum search radius for the climate station choice lists (kilometers or miles). Typically one uses the closest, but the user may want to select a station more typical of the climate for the field being simulated. An example of not selecting the closest station might occur in mountainous areas where the adjacent station does not typify the climate for the simulated field.
- Tooltip delays sets the delay time for the initial appearance of the tooltip and for the dismissal of the tooltip box from the screen.

- ‘**Output**’ - opens a tab that allows the user to set the following output options:
  - Reporting period for detailed submodel reports.
  - Flags for submodel reports which give model developers and selected users more detailed output than is available through the interface. See the Appendix for flag numbers to set for submodel reports.
- ‘**Email**’ - opens email configuration settings:
  - Sender Addr - enter the default email address of the sender.
  - SMTP Server - enter your mailhost SMTP server address.
  - Comments - enter a default recipient for comments to the WEPS developers.
  - Bugs - enter a default recipient for a bug report.
- ‘**Run**’ - opens a tab with run options:
  - Run Length Type - click a button to select a type of run length as either the NRCS method (specifies a fixed number of cycles), use simulation run start and end dates on the main screen, or specify the use of rotation cycles on the main screen.
  - Alternative weather files - click the check box next to the name of a weather file type to use alternative weather file (e.g. measured wind data). Then enter the file name and path or browse for the file by clicking the folder icon on the main screen.
- ‘**Executables**’ - opens a tab that allows the user to select executable files and command line arguments:
  - WindGen.exe - enter the path and file name for the default Windgen executable.
  - WindGen cmd - enter the default Windgen command line arguments (see Appendix for argument list).
  - CliGen.exe - enter the path and file name for the default Cligen executable.
  - CliGen cmd - enter the default Cligen command line arguments (see Appendix for argument list).
  - WEPS.exe - enter the path and file name for the default WEPS executable.
  - WEPS cmd - enter the default WEPS command line arguments (see Appendix for argument list).
- ‘**Directories**’ - opens a tab that allows the user to select the directories used for templates, skeleton files, databases, and projects:
  - Man Template - enter the default directory for the management templates.
  - Man Skeleton - enter the default directory for the management skeleton files.
  - Man Op DB - enter the default directory for the management operation database files.
  - Crop DB - enter the default directory for the crop database files.
  - MCREW Dir - enter the default directory for MCREW configuration files.
  - Soil DB - enter the default directory for the soil database files. If an ifc file is entered, the ‘Soil DB spec’ field below should be left blank.

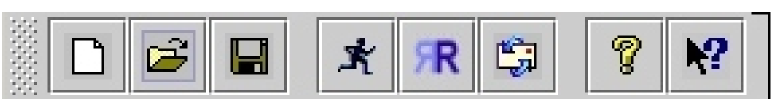
- Soil DB spec - enter the OBDC Driver specification for SSURGO database.
- Projects Dir - enter the default directory for the project directories and files.

At the bottom of the Configuration panel are three buttons:
- OK - closes the configuration window.
- Save - saves any changes to the configuration window.
- Help - opens general help for the configuration window.

Tools
This menu contain various tools available for use with WEPS including:
- '**Send Email**' - send email comments to WERU, providing the computer is connected to the Internet. The user can also attach the current project and run files.

Help
This menu contains help options for WEPS including:
- '**About WEPS**' - gives the current version of WEPS.
- '**Help Topics**' - brings up a window containing the WEPS online help system.

Button Bar

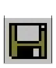


At the top of the main WEPS window (below the menu bar) is a series of buttons with icons, designed to help the user in the operation of WEPS.

Project Operations

This button allows user to create a new project from scratch. This has the same function as selecting '**New**' under '**Project**' on the menu bar.

This button opens an existing project. This has the same function as selecting '**Open**' under '**Project**' on the menu bar.



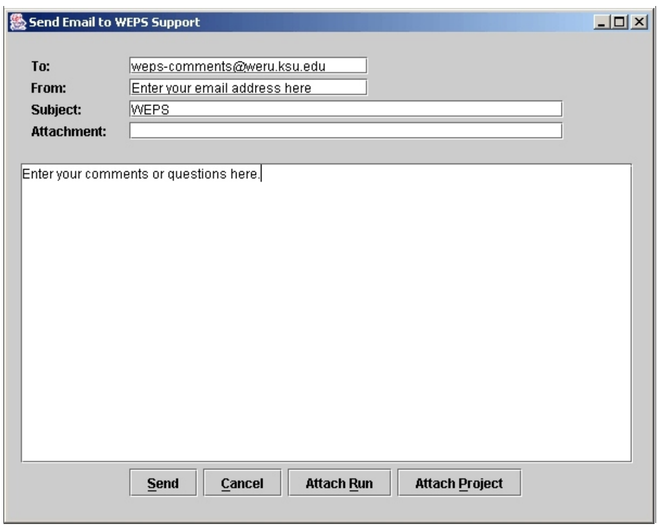
This button saves the currently displayed project to its current file name. This has the same function as selecting '**Save**' under '**Project**' on the menu bar.

Run and Help

This ‘**Run**’ button begins a simulation run.

This ‘**Reload**’ button allows the user to view the output window.

This ‘**Email**’ button allows the user to email comments to WERU along with the contents of the current Project, if desired. Clicking the ‘**Email**’ button brings up a separate window (see below).



The user should enter an email address and a short message. Click the appropriate box at the bottom of the window to attach the current project and/or run files to your email. See the ‘Interface Reference: Making a WEPS Run’ section in the User Manual for a description of projects and run files. If you are connected to the Internet, clicking ‘**Send**’ will email the message to WERU, along with any attached files so that your inquiry can be answered.

This ‘**Question**’ button opens the general help system for WEPS.

This ‘**Context Help**’ button provides help for a particular item on the WEPS screen. Clicking the ‘**Context Help**’ button on the tool bar and then clicking on the item on the screen for which help is desired brings up a help screen for that item.

Field View and Barriers

Field View

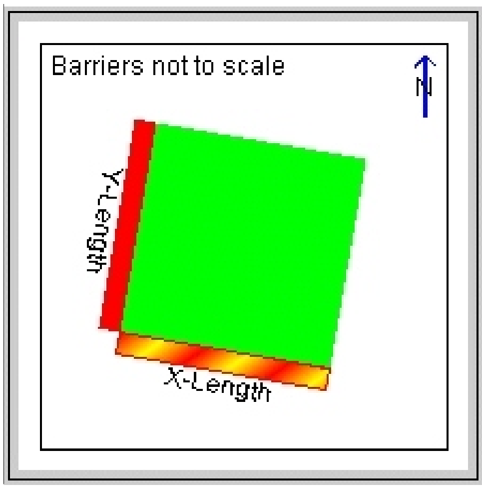


Figure 2.2. Field View Panel.

The Field View Panel (Fig. 2.2) is located in the center of the WEPS1.0 main screen. It is designed to give the user a view of the field size, shape, and orientation (green). The placement of any barriers present is also displayed (red). Note that if the ratio of length to width of the field or barriers is too great to display to scale, this will be indicated within the panel and an approximation of the field or barrier shape will be displayed. This panel is for viewing only and is not editable.

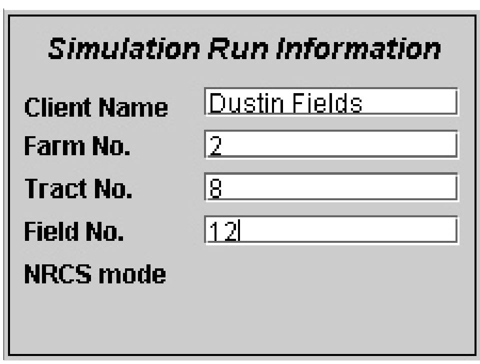


Figure 2.3. Simulation Run Information Panel.

Simulation Run Information

Customer information for a simulation run is entered by using the left panel of the WEPS1.0 main screen (Fig. 2.3) labeled ‘Simulation Run Information’.

The Client Name as well as the Farm, Tract, and Field Number for the simulation run can be entered by typing the information in the appropriate box in the panel. Note that there are three options for run length type. The NRCS mode specifies a fixed number of cycles. This option is locked for NRCS field use. Other users can specify a simulation run start date and end date on the main screen, or specify the number of rotation cycles to use on the main screen. The length of run is controlled through the ‘Run’ tab on the ‘Configuration’ panel (see the discussion on ‘Configuration’ for more details).

Wind Barrier Information

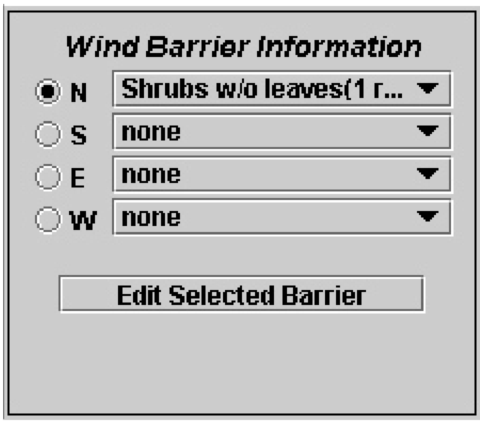


Figure 2.4. Wind Barrier Information panel.

The wind barrier panel (Fig. 2.4) is used to add barriers to the field borders. Note that WEPS1.0 only allows barriers on the borders of the field. The barrier for each field border is labeled 'N' for north, 'S' for south, 'E' for east, and 'W' for west. The barrier type can be selected from the drop down list in the panel by clicking the down arrow to the right of the barrier type to bring up the list of available barriers and clicking on the appropriate barrier. Once a barrier type is selected, the barrier properties may be viewed and edited by clicking the 'Edit Selected Barrier' button at the bottom of the panel. A separate panel is opened where one may enter the barrier width, height, and porosity in the appropriate space. Note that the area of the barrier is displayed but cannot be edited. If barrier properties are modified, it will be noted in the type list with a '<mod>' designation before the type name. {If a barrier other than 'None' is selected but 'Edit Selected Barrier' button does not open the properties panel, please click the radio button off, then on again.} To remove a barrier from the field, click the radio button to select it (notice the barrier will be 'highlighted' when selected) then select the barrier type 'None' to remove it.

Simulation Region Information

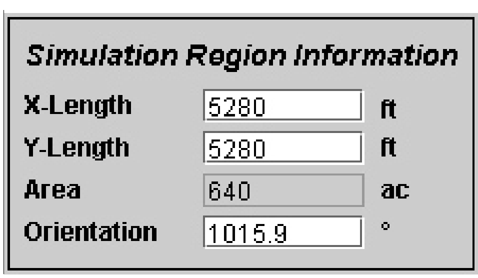


Figure 2.5. Simulation Region Information panel.

The 'Simulation Region Information' panel is shown in Figure 2.5. To describe the simulation region, the field dimensions are entered as an X-Length and a Y-Length. Note that the area of the region will be displayed but can not be edited. To orient the field direction, simply type in the angle in degrees of deviation from north of the field. Note that the field will only rotate in a range of ±45 degrees. By rotating and adjusting the field length and width, the user should be able to obtain the desired field size and orientation. Creating special shapes or configurations such as circles and strip cropping are discussed under "Using WEPS for Conservation Planning".

Choosing a Location

Choosing a location within WEPS defines the physical location of the field to be simulated. This location information is used within WEPS to select the weather stations (CLIGEN and WINDGEN) to be used for the simulation.

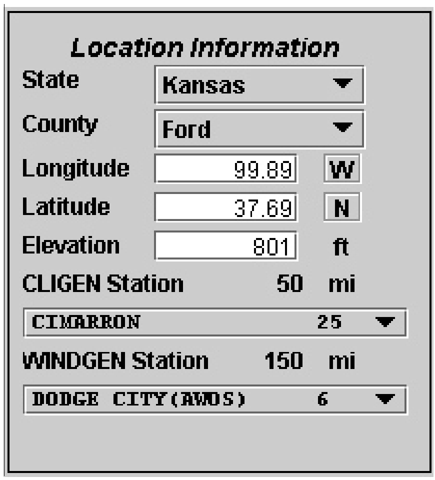


Figure 2.6. 'Location Information' Panel.

Location information is entered through the rightmost panel labeled 'Location Information' on the main interface screen (Fig. 2.6). Select the state and county of interest from the drop down list by clicking the down arrow to the right of the state and county. The CLIGEN and WINDGEN stations nearest to the center of the selected county will then determined by the interface and listed. The longitude and latitude of the location can also be entered, which will bring up the nearest CLIGEN and WINDGEN stations. Once the stations are displayed, the user can click on the down arrow next to the stations to bring up a list of nearby stations from which to choose an alternative station if desired. The State and County as well as the Longitude and Latitude fields are optional and can be added to or removed from the interface through the 'Miscellaneous' tab of the 'Configuration' panel (see the discussion on 'Configuration' for more details). {Right clicking on the listed CLIGEN or WINDGEN station name in will bring up information about the weather station. This information may be useful in determining which station best fits the location and conditions desired. This feature is not currently implemented.}

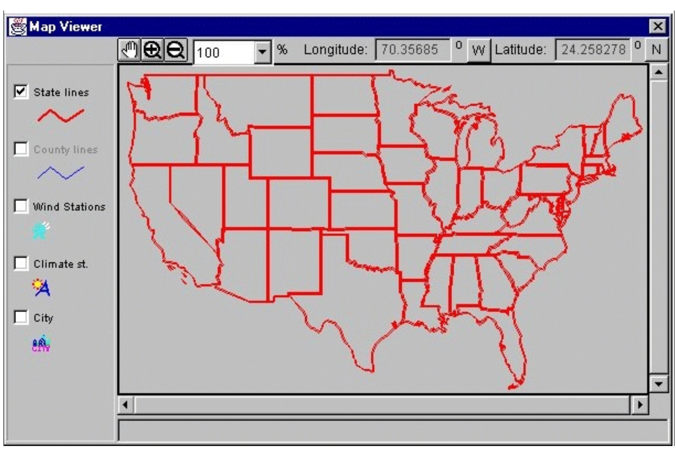


Figure 2.7. Map Viewer window.

An alternative method to choosing a location is by using the map. Clicking on the 'Use Map' button displays 'Map Viewer' with a map of the United States (Fig. 2.7). The map can be 'zoomed' in or out by selecting a % magnification from the dropdown list at the top the map viewer screen. Alternatively, the user may increase or decrease magnification by clicking the zoom in or zoom out buttons and then clicking a location within the map window. When zoomed to greater than 100%, one can ‘drag’ the view of the map by clicking on the ‘move’ icon  then holding down the left mouse button and drag the map view to the desired location. Clicking the check boxes in the left side of the Map Viewer window will display county lines (must be zoomed at 400% or greater), the location of CLIGEN stations, WINDGEN stations, and major cities on the map. Double clicking a location on the map will select the nearest CLIGEN and WINDGEN station and close the map viewer. The map viewer is a convenient way to view all of the climate stations within a state or region. **{Note! This feature is currently not implemented in the WEPS 1.0 interface.}**

Notes

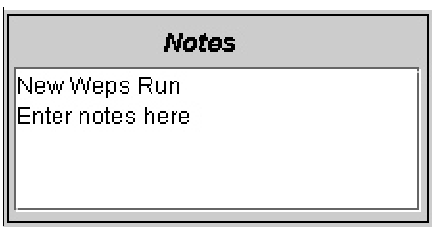


Figure 2.8. ‘Notes’ Panel.

The user may also type in notes for the run in the ‘Notes’ panel (Fig. 2.8). These notes will be displayed and can be edited on the Project Summary output report.

Choosing and Editing a Management Rotation

Management rotation scenarios for a simulation run can be selected or a rotation editor can be opened by using the ‘**MCREW**’ button on the left side of the bottom panel of the WEPS main screen (Fig 2.9).

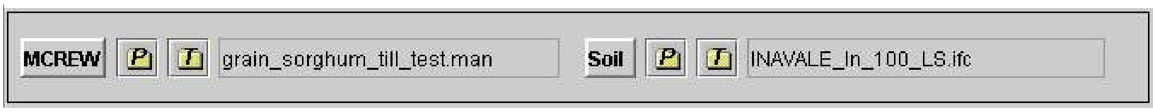


Figure 2.9. Bottom panel of the WEPS main screen with the management box on the left.

A management rotation for a simulation run can be selected from pre-generated management files. Click the template folder in the management box which is located in the bottom panel of the main screen (Fig. 2.9) and then select the management rotation desired from the template directory. Once selected, the name of the management file will appear in the panel. The user may also select management files stored in project directory by clicking on the project folder . Usually, management rotation files in a WEPS project are simply copies of those selected from the “Template” directory, but they may have local “project specific” modifications. To open the Management Crop Rotation Editor for WEPS (MCREW), double click on the ‘**MCREW**’ button MCREW , on the left side of the management box. This will open the MCREW window (Fig. 2.10), which allows the user to view, edit, and save management rotation information under a new file name.

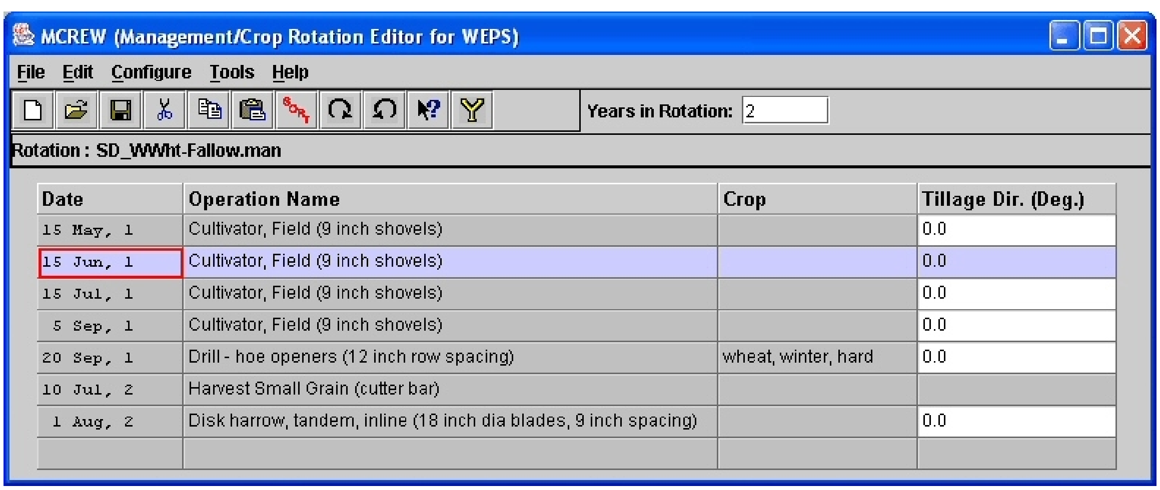


Figure 2.10. Management Crop Rotation Editor for WEPS (MCREW) window.

MCREW's principle purpose is to create/modify/construct management rotation files required for making WEPS simulation runs. Although it is an integral component of the WEPS 1.0 interface, it can be used as a stand alone program to edit management rotation files independent of the WEPS and was designed to be configurable for uses outside of WEPS. Much of MCREW's functionality, behavior and visual appearance is controlled via ASCII XML-based configuration files. Changing the appropriate configuration files allows one to specify the structure and definition of the management/crop rotation file format and the user's ability to view and edit specific operation and/or crop properties, etc.

MCREW is fundamentally a date ordered list of management operations. This release of MCREW provides the user with a tabular, row oriented view of the operations and their associated dates. In WEPS, a management operation is defined as any human initiated process, such as a tillage event, seeding, irrigation setting, etc. If the operation triggers the WEPS model to start simulating the growth of a crop (or any other plant vegetation supported with a crop database record containing the necessary vegetation growth parameters), e.g. a planting/seeding/transplanting operation, then the name of that crop is listed in the row next to the name of the operation.

Using MCREW

MCREW is designed to allow easy creation and editing of management rotation files for WEPS. The MCREW screen consists of 5 major components:

1. Menu bar

The menu bar consists of assorted menu options which provide access to MCREW's functions. Functions of the menu bar are discussed later in this document.

2. Button bar

The Button toolbar consists primarily of buttons that provide quick access to some of MCREW's most common functions. Functions of the buttons are discussed later in this document.

3. Years in Rotation

Years in Rotation: 2

On the right of the button bar, the user may view and edit the number of years in a rotation cycle.

4. Rotation

Rotation : SD_SpWheat-Fallow.man

This window displays the name of the management rotation which is loaded. If the management rotation name is too large, a scroll bar is provided so the user can view the entire rotation name.

5. Table View

Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 Apr, 1	Chisel plow - 2 inch wide straight pts		0.0
20 Apr, 1	Drill - double disk openers (8 inch row spacing)	wheat, spring	0.0
15 Aug, 1	Harvest Small Grain (cutter bar)		
15 May, 2	Cultivator, Field (9 inch shovels)		0.0
15 Jul, 2	Cultivator, Field (9 inch shovels)		0.0
15 Sep, 2	Cultivator, Field (9 inch shovels)		0.0

The Table View displays the sequence of operations with their associated dates and any crops planted in a tabular format. Spreadsheet style editing functions are available to manipulate the order, selection, and removal of operations and/or crops, etc. More details of the editing functions of the Table View are given later in this section.

Opening and Saving MCREW files

In WEPS 1.0, there are two primary locations that management rotation files exist:

1. In the "Management Templates" directory.
   This is the location that complete or partial (single or multi-crop year) management rotation files are kept. Files in this directory always show up on the management rotation selection choice lists. Typically, management

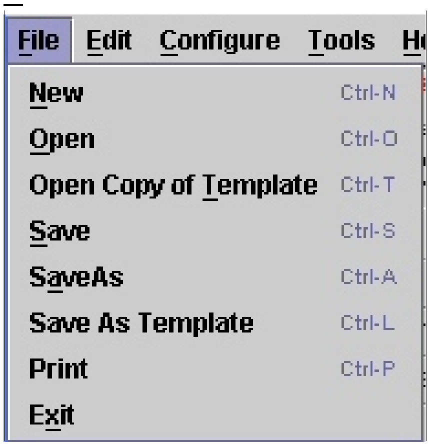
rotation files to be used in WEPS projects are selected from previously built management rotation files or are constructed from several partial management rotation files located in this directory.

2. Within a "WEPS Projects" directory.

Any edited or viewed management rotation file used in a WEPS project run is always located in that WEPS project's directory. There can be more than one management rotation file in a WEPS project. The current management rotation file to be used when making a WEPS run is the one specified in the "weps.run" file (e.g., the one listed in the "management" input field on the WEPS main screen. Usually, management rotation files in a WEPS project are simply copies of those selected from the "Template" directory, but they may have local "project or run specific" modifications.

Menu Bar Functions

File



Once the MCREW window is open, rotation files can be created from scratch, saved in the desired location and/or other rotation files opened for editing. The **"File"** menu contains all of these options, with the common functions (**"New"**, **"Open"**, and **"Save"**) also being available on the icon button toolbar:

- **New** Ctrl-N
  Opens an empty unnamed rotation file.

- **Open** Ctrl-O
  Displays an "**Open File**" dialog box from which the user can select the desired rotation file from those in the current project.

- **Open Copy of Template** Ctrl-T
  Displays an "**Open File**" dialog box from which the user can select the desired rotation file from the "Management Templates" directory. A copy of the selected file is then added to the current WEPS project and made available for editing in MCREW.

- **Save** Ctrl-S
  Saves the current project's rotation file being edited.

- **Save As** Ctrl-A
  Displays a "**Save File**" dialog box from which the user can specify the desired filename to save the rotation file for the current project.

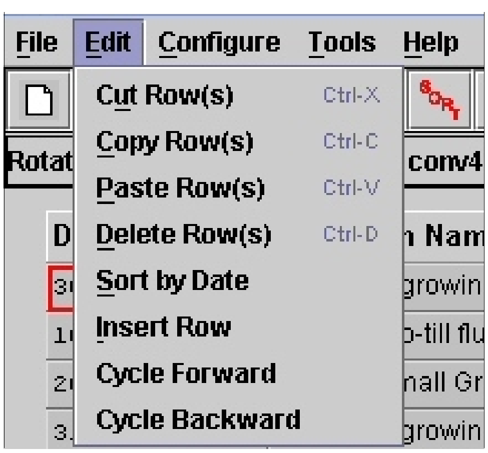
- **Save As Template** Ctrl-L
  Displays a "**Save File**" dialog box from which the user can specify the desired filename to save the rotation file into the "Management Templates" directory.

- **Print** Ctrl-P
  Prints MCREW Table View. Clicking this item displays a print dialog box through which the MCREW table view can be printed (Ctrl-P).

- **Exit**
  Exits MCREW. If MCREW finds that the rotation file has been modified and not saved, it will display a popup message and ask the user if they want to save it before leaving.

NOTE: Currently when one "Saves" a management rotation file for the current WEPS project, that file is not physically saved into the current project's directory until the project itself is saved via the WEPS main screen menu "Save" option or automatically prior to initiating a WEPS run. Thus, a remote possibility exists for a "saved" WEPS management rotation file to disappear if the computer crashes prior to "saving" the current project. This will be corrected in a future release.

Edit



A WEPS 1.0 rotation file is simply a date-ordered list of management operations. MCREW provides basic editing functionality to insert, delete, modify, and change dates for those operations. In WEPS, each operation is defined by a list of physical processes, such as residue burial, soil inversion, flattening standing residue, creation of ridges, planting a crop, etc., which are described to the model via one or more parameter values.

In it's most basic form then, one can "see" a WEPS management rotation file within MCREW via the table view.

The primary editing functions available are accessible via the ‘Edit’ menu option. The table view editing functions are:

- **Cut Row(s)** Ctrl-X
  Remove the currently selected operation row(s) from the rotation and store them in a temporary buffer for possible pasting back into the rotation later.

- **Copy Row(s)** Ctrl-C
  Copy the selected operation row(s) from the rotation and store in a temporary buffer for possible future pasting back into the rotation.

- **Paste Row(s)** Ctrl-V
  Paste the previously cut or copied operation row(s) above the selected operation (or top one if more than one is selected).

- **Delete Row(s)** Ctrl-D
  Delete the selected operation row(s) (or bottom one if more than one is selected).

  The “**Cut**”, “**Copy**”, and “**Paste**” buttons on the toolbar can also be used for those operations.

- **Sort by Date**
  Sort the operations in ascending order by date. See “Management File Date Adjustment Functions” below.

- **Insert Row**
  Insert a blank row above the selected row.

- **Cycle Forward**
  Selecting this option causes the last year in the rotation to become the first year in the rotation while the other rotation years are incremented by one year. See “Management File Date Adjustment Functions” below.

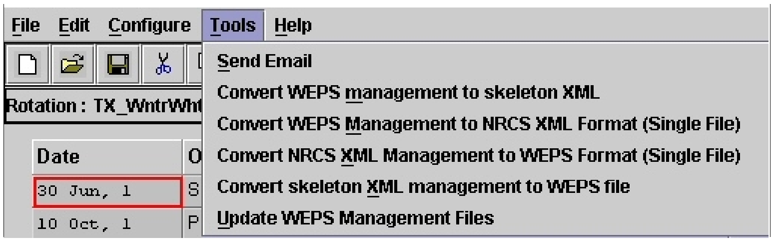
- **Cycle Backward**
  Selecting this option causes the first year in the rotation to become the last year in the rotation while the other rotation years are decremented by one year. See “Management File Date Adjustment Functions” below.

Configure

This menu is not implemented.

Tools

The 'Tools' menu item lists many tools and utilities related to the use of MCREW.



- **Send Email**
  Provides a method to communicate with WEPS developers via email.

- **Convert WEPS management to skeleton XML**
  Converts multiple WEPS management files in a single directory to the NRCS shared summary management file format.

- **Convert WEPS Management to NRCS XML Format (Single File)**
  Converts a single WEPS management file to the NRCS shared summary management file format.

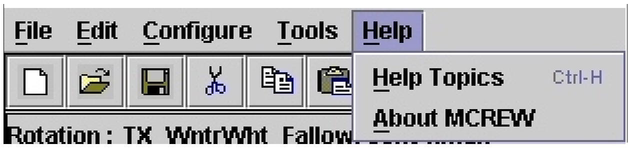
- **Convert NRCS XML Management to WEPS Format (Single File)**
  Converts single NRCS shared summary management files to the WEPS management file format.

- **Convert skeleton XML management to WEPS file**
  Converts multiple NRCS shared summary management files to the WEPS management file format.

- **Update WEPS Management Files**
  Updates management files with the most current crop and operation database parameters.

Help

The 'Help' menu item displays help options about MCREW and includes:



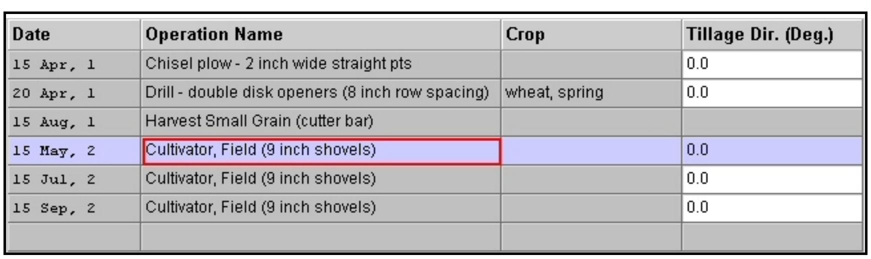
- **Help Topics** Ctrl-H
  Opens a window containing the MCREW online help system.

- **About MCREW**
  Displays the current version of MCREW.

Editing Using the Table View

Row and Cell Selection Functions

The mouse is currently the primary method used to "select" either a row and/or an individual table cell. If a particular table cell cannot be directly edited within the cell, this is indicated by a gray background, (e.g., Date, Operation Name or Crop) and the row is selected (indicated by the dark blue background in all cells within the row) along with the individual cell (indicated by the red rectangular border around the cell). See the figure below for an example of a row selection after a left mouse click on the "Cultivator" operation cell.



Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 Apr, 1	Chisel plow - 2 inch wide straight pts		0.0
20 Apr, 1	Drill - double disk openers (8 inch row spacing)	wheat, spring	0.0
15 Aug, 1	Harvest Small Grain (cutter bar)		
15 May, 2	Cultivator, Field (9 inch shovels)		0.0
15 Jul, 2	Cultivator, Field (9 inch shovels)		0.0
15 Sep, 2	Cultivator, Field (9 inch shovels)		0.0

If the table cell can be directly edited on the table (indicated by a white background in the table cell), then a left mouse button selection will select the individual cell and immediately allow the user to manually "edit" the value in the cell. For example, left clicking in a "Tillage Dir." cell with a white background activates that cell for editing.

One can select multiple rows at one time by depressing and holding down the left mouse button on the first row to be selected and dragging the mouse cursor over the additional contiguous rows to also be selected. Release the left mouse button on the last row to be selected. All selected rows will be highlighted with a light blue background. The cell the mouse cursor was in when first depressing the left mouse button will be identified by the red rectangular border around it (see the figure below).

Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 Apr, 1	Chisel plow - 2 inch wide straight pts		0.0
20 Apr, 1	Drill - double disk openers (8 inch row spacing)	wheat, spring	0.0
15 Aug, 1	Harvest Small Grain (cutter bar)		
15 May, 2	Cultivator, Field (9 inch shovels)		0.0
15 Jul, 2	Cultivator, Field (9 inch shovels)		0.0
15 Sep, 2	Cultivator, Field (9 inch shovels)		0.0

The user can append contiguous rows adjacent to a previous, row or multi-row selection, by holding down the "shift" key and clicking the left mouse button on the last desired contiguous row to append to the selection. This is similar to how Microsoft Windows append selection works with the "shift" key depressed.

Similarly, one can append non-contiguous rows (or row) by holding down the "ctrl" key and making an additional multi-row (or single row) selection similar to the original row or multi-row selection (see figure below). As many non-contiguous rows can be selected, as desired, via this method. Again this is similar to how Microsoft Windows non-contiguous selection method works with the "ctrl" key depressed.

Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 Apr, 1	Chisel plow - 2 inch wide straight pts		0.0
20 Apr, 1	Drill - double disk openers (8 inch row spacing)	wheat, spring	0.0
15 Aug, 1	Harvest Small Grain (cutter bar)		
15 May, 2	Cultivator, Field (9 inch shovels)		0.0
15 Jul, 2	Cultivator, Field (9 inch shovels)		0.0
15 Sep, 2	Cultivator, Field (9 inch shovels)		0.0

Any row or multi-row selection can be de-selected and replaced by simply clicking the left mouse button anywhere within the MCREW table display (with no keyboard keys pressed).

Row Editing Functions

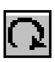
Using the **"Edit"** menu, the user can cut, copy paste and delete rows. One can also insert a new blank row ("**Insert Row**") immediately above the row containing the cell outlined in red. Additionally, the user can press the right mouse menu button to display a popup menu that contains row editing functions (see the figure to the left). The **“Set Date”** and "**Adjust Date**" options will be described below under “Management File Date Adjustment Functions”.

Also, one can insert the contents of another (previously created) management file via the "**Insert Management File**" option immediately above the row containing the cell identified with the red rectangular box. The "FileChooser" dialog will popup allowing the user to select the desired management file from which to include all the operations and their associated dates from into the current management file being edited.

Management File Date Adjustment Functions

There are several date adjustment functions available in MCREW available in the "**Edit**" menu and the icon toolbar. These operations are:


Sort by Date


Cycle Forward

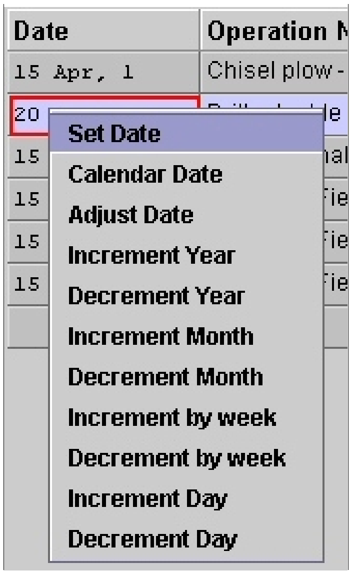

Cycle Backward

The "**Sort by Date**" function sorts the management operations by ascending date order. Thus, the user can adjust/set the dates of management operations without having to worry about whether they are in the correct sequential order at that time. When the user wants to see the list of operations in the correct date ordered format, they can simply select the **"Sort by Date**" function from the toolbar icon or the "**Edit**" menu.

MCREW will not allow the user to save a WEPS management file without the operations being listed in date order. The user is given the options to automatically sort them if they are not sorted during a management file save operation or to go back to the editor and allow the user to correct the problem(s) manually.

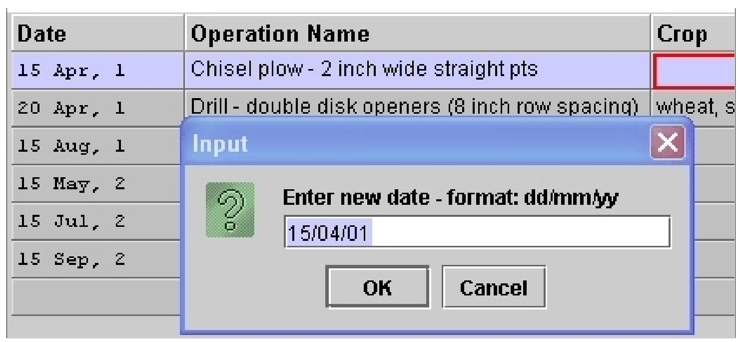
The "**Cycle Forward**" and "**Cycle Backward**" functions will rotate the "rotation year" of the management operation dates forward or backward in increments of one year. For example, a three year management file rotation "Cycled Forward" would change the operation dates in the first year to the 2nd year, those in the 2nd year to the 3rd year and those in the 3rd year to the 1st year. Thus, the crops grown and harvested in the first year would now occur in the second year, etc. Likewise, a rotation "Cycled Backward" would shift the rotation the opposite direction, making the 2nd year operations occur in the first year, etc.

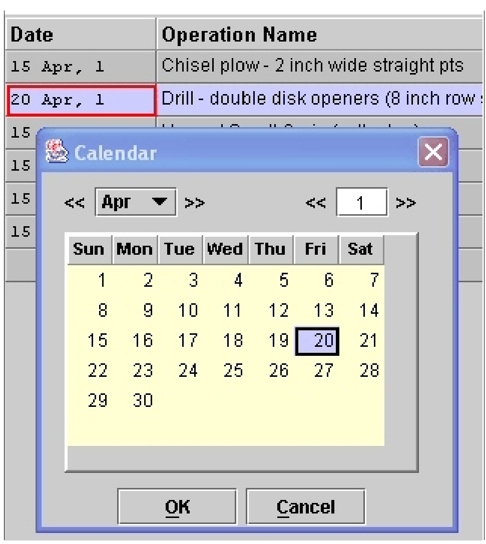
Date Column Editing Functions



Limited date editing functions are available by right clicking on a cell in any column. Clicking the right mouse button while the cursor is on a date column cell, causes a date editing popup menu to appear which has additional date editing functions (see the figure to the left). These functions allow the user to adjust dates for one row or all operation rows selected (highlighted in blue) simultaneously.

Selecting the **"Set Date"** option will display a dialog box that allows the user to type in a specific date (day/month/rotation year) for all operation rows selected (highlighted in blue). The figure below shows an example of "**Set Date**" popup window.

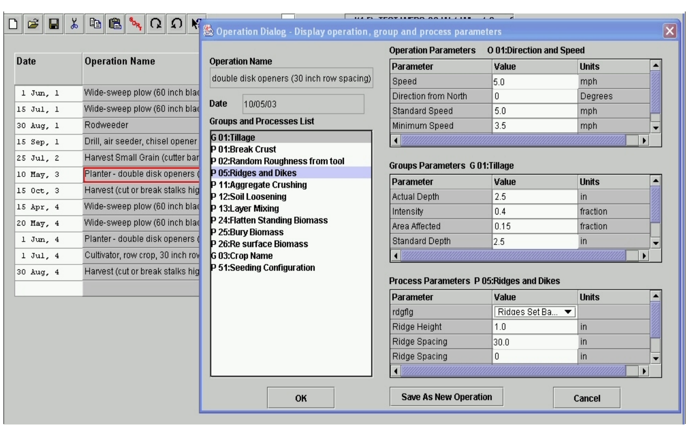




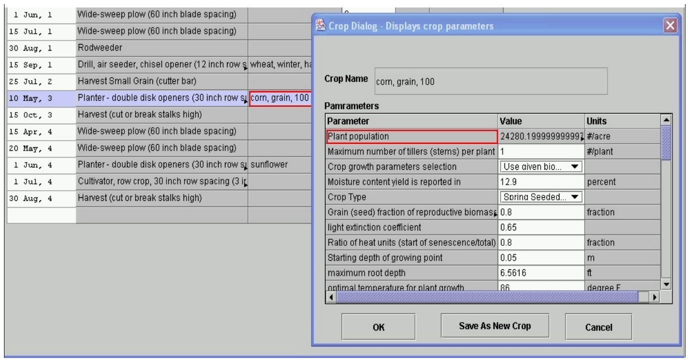
The "**Calendar Date**" option displays a popup calendar to aid in adjusting dates. Double left mouse clicking in a date cell, displays the popup calendar as well. This calendar window allows the user to select the desired date. The calendar allows the user to increment (>>) or decrement (<<) the month and year values if desired. Then the day of the operation within that month/year can be selected. The user can either double right mouse click on the day value or click on the "OK" button to accept the specified date (see the figure to the left).

The "**Adjust Date**" function is available from this menu, but year, month, week, and day increment and decrement functions are also available. They apply to all dates that are selected. The user can adjust the operation dates on the selected rows. Selecting the "**Adjust Date**" option will display a dialog box allowing the user to adjust the operation dates in the selected rows by a specified ± number of days, months, or years (see the figure below).

Operation and Crop Drilldown Screens



Both the Operation and Crop cells have a "drilldown" function available that allows the user to display a popup screen that makes many of their specific parameter values viewable and/or editable. The specific content of these screens depend both upon the type of crop or operation and specific XML-format configuration files which describe which parameters are to be made viewable or hidden to the user and if viewable, whether or not they are editable by the user. In addition, for each parameter that is displayed, the prompt information for the parameter is described in these XML-format files. Examples of operation and crop drilldown screens are shown to the left.



The cell-specific drilldown functions are available for single cell selections (right mouse button click - red rectangular box around the selected cell) and for the identified single cell selection (red rectangular box around the cell) when a multi-row selection has been defined via the left mouse button selection method. The operation drilldown screen is accessible if the selected cell is in the operation column and a crop drilldown screen is accessible if the selected cell is in the crop column.

Selecting/Replacing Operations and Crops

A new operation can be added to a blank line or a different operation can be selected to replace an existing operation. This is accomplished by double clicking the left mouse button with the mouse cursor in an operation cell. This action will popup the "FileChooser" dialog. It allows the user to select a management operation record from within the window. The user can also access this "FileChooser" dialog from the "**Add/Change Operation**" menu option via the right or left mouse menus (described earlier under “Row Editing Functions”).

A Crop can be specified for planting (and subsequent harvest) only for operations which contain the "planting/seeding" process. Those that have this process defined will either display the name of the crop to be planted in the "crop" column or display the string "no crop", signifying that no crop is to be planted or it hasn't yet been selected by the user. A crop can be added or an existing crop can be replaced by double clicking the left mouse button with the cursor in a crop cell. This action will popup the "FileChooser" dialog. It allows the user to select a crop record from within the window. The user can also access this "FileChooser" dialog from the "**Add/Change Crop**" menu option via the right or left mouse menus (described earlier under “Row Editing Functions”).

Choosing a Soil

A soil for a simulation run is selected using the ‘Soil:’ box on the right side of the bottom panel of the WEPS1.0 main screen (Fig. 2.11).

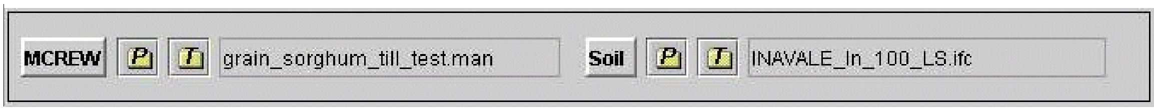


Figure 2.11. Bottom panel of the WEPS main screen with the soil box on the right.

The soil for a simulation run can be selected from the NRCS SSURGO database by clicking the ‘**Template**’ folder to the left of the soil name.

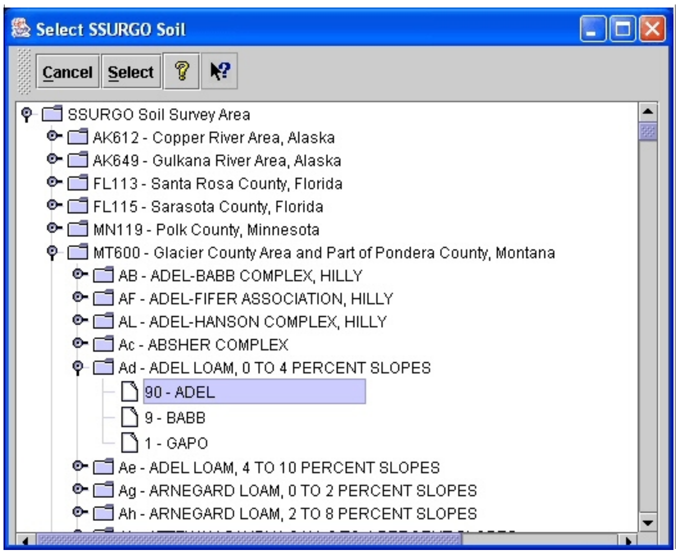


Figure 2.12. The ‘Select SSURGO Soil’ window.

Clicking on the **‘Template’** folder opens a window titled ‘**Select SSURGO Soil**’ (Fig. 2.12). Navigate through the database tree to find the soil survey area (or county) desired. Navigation is performed by clicking on the open ‘key’ symbol to display the next level of the tree. To close a level of the tree, click close ‘key’ symbol. The soils files are listed according to the soil map unit symbol, map unit name, surface texture, and local phase. Selecting a soil then lists its components and the percent each component contributes to the map unit. Click a soil component to highlight it and click the ‘**Select**’ button Select at the top of the screen (or double click the component with the left mouse button). This action converts the soil from the SSURGO database to a WEPS soil file format (with an ‘ifc’ extension) and returns the user to the main screen. The loaded soil file name will appear in the soil box window. Clicking the ‘**Cancel**’ Cancel button on the ‘**Select SSURGO Soil**’ window aborts the selection of a new soil. The ‘**Question**’ button opens the general help system for WEPS. The ‘**Context Help**’ button provides help for a particular item on the toolbar of the ‘**Select SSURGO Soil**’ screen. Clicking the ‘**Context Help**’ button and then clicking on an item on the toolbar displays a help screen for that item.

Soils that have been previously loaded to projects or modified and saved to another name can be opened by clicking on the '**Project**' folder. This will open a window where the user can select the desired soil or type in the soil file name.

To view the soil data, double click on the button labeled '**Soil**', on the left side of the soil box. This will open the WEPS Soil User Interface screen (Fig. 2.13), which allows the user to view, edit (disabled for NRCS), and save the soil information under a new file name under the project.

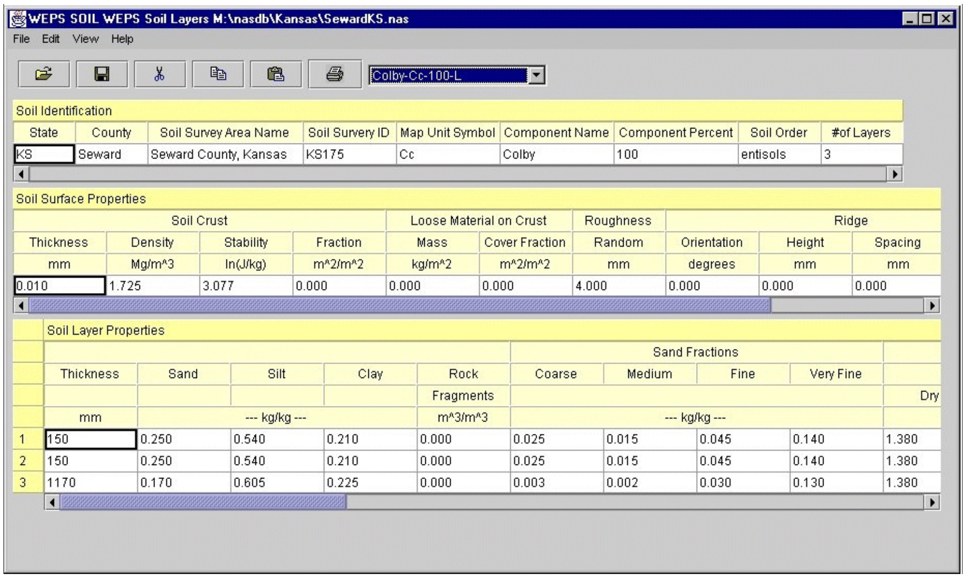


Figure 2.13. WEPS Soil User Interface screen.

Making a WEPS Run

WEPS Projects

A "WEPS project" is a directory that can be thought of as a working area where WEPS simulation runs are created and stored along with their outputs. A project stores all the parameters for the current simulation run being prepared within the WEPS interface as well as any past WEPS simulation runs. For example, a particular project may represent a directory for an individual farm under which all the simulation runs for each field and management alternatives on that farm are stored. When a project is saved, all of the information contained on the current interface screen is stored in the project directory. Multiple WEPS projects can be created and given various names by the user. These directories can also be managed (i.e., renamed, deleted, or moved) using a file manager such as Windows Explorer (not provided with WEPS).

All WEPS simulation run results are stored in subdirectories for a WEPS project under that project's directory. A WEPS run subdirectory is created every time a simulation run is made. A WEPS run subdirectory stores all inputs that were used to make the simulation run, together with the outputs generated from those inputs. Thus, one is able to reproduce the identical outputs at a later date (using the same version of WEPS 1.0 and the weather generators/databases) because the original inputs are still available. The run directories make it relatively easy for one to archive, rename, or remove WEPS runs as alternative erosion planning scenarios are tested for a field or farm. If, for example, a change is made to create a different management alternative, all the information pertaining to this new scenario will be saved to a new subdirectory (WEPSrun name) when the simulation is made.

Project Operations

Clicking the '**Project**' menu item displays a list of various operations pertaining to WEPS projects.

The ' **New**' menu item allows the user to create a new project from scratch. Clicking on this menu item causes WEPS to check for any unsaved changes to the displayed parameters. If there are unsaved changes, the user is asked if they want to '**Save current project?**'. If the user clicks '**Yes**', the current parameters are saved to the old (current) project. A file chooser then appears that allows the user to specify a name for the new project. The current WEPS interface screen is then cleared and the newly created project becomes the current project. If the user clicks '**No**', a file chooser opens immediately allowing the user to name the new project to be created and resets the parameters to the system defaults without saving any changes to the previous (current) project. In either case, the user can then proceed to build the new project by entering information on the interface screens. If the user clicks '**Cancel**', the process of creating a new project is aborted and the screen returns to the previous project.

The ' **Open...**' menu item opens an existing project. Clicking on this menu item causes WEPS to check for any unsaved changes to the displayed parameters. If there are unsaved changes, the user is asked if they want to '**Save current project?**'. If the user clicks '**Yes**', the current parameters are saved to the old (current) project. A file chooser then appears that allows the user to specify the name of an existing project to open. The newly opened project becomes the current project. If the user clicks '**No**', the old project is closed without saving any changes and a file chooser opens which allows the user to select an existing project to be re-opened. In either case, the user can then proceed to view the project information or modify the project by entering information on the interface screens. If the user clicks '**Cancel**', the process of selecting a previous project is aborted and the screen returns to the old project. When leaving the project or WEPS, the user is asked if they want to save the current project.

The ' **Save**' menu item saves the current project to the current project name.

'**Save As...**' allows the user to save a copy of the currently displayed project to a new name. The copy then becomes the current project.

The default project folder (i.e., directory) under which new projects will be created and existing projects will be opened can be specified under the '**Directories**' tab of the '**Configuration**' window. Enter the default directory on the line labeled '**Projects Dir**'. By default, the last project that was open when WEPS was exited is the current project when WEPS is restarted.

Make a WEPS Run

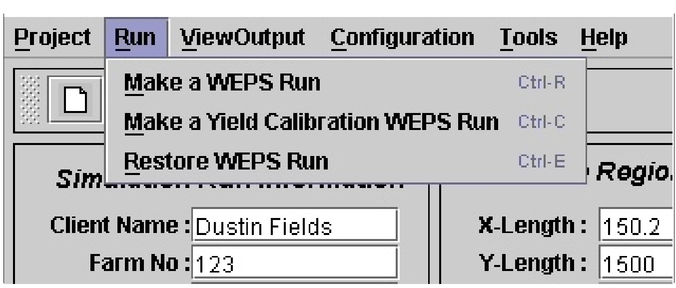
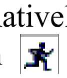


Figure 2.14. The run menu of the main screen.

Once the desired information is entered through the interface screens, a simulation run can be started. Clicking on the '**Run**' menu, then selecting '**Make a WEPS Run**' (Fig. 2.14), begins a WEPS simulation run. Alternatively, one can click the run button  on the button bar to

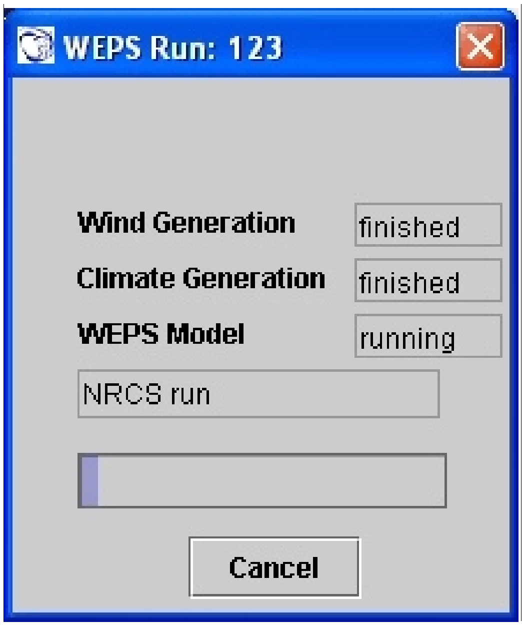


Figure 2.15. WEPS run status window.

begin a WEPS simulation run. A box will appear asking the user to "**Enter a run name**". When a run name has been entered, the simulation begins and a window appears which shows the status and progress of the run (Fig. 2.15). Upon completion of a run, an output summary report will appear for the user to review and print if desired. The summary report is saved in the run directory along with more detailed output reports for later retrieval. The summary and detailed reports for a run can be viewed or created any time by the user. See the section of the WEPS User Manual titled '**Output**' for more detailed descriptions of the WEPS output types and how to select them for viewing or printing.

Make a Yield Calibration WEPS Run

Differences in crop management of producers or local climate variances may result in crop yields, generated by WEPS, that do not reflect the actual yields observed by a producer. WEPS provides a method to "calibrate" yields and associated biomass from WEPS so that they more accurately reflect those of individual producers or a county as a whole. The following steps describes how to make a yield calibration run.

a) Within MCREW, press the '**Yield Calibrate**' button  to display additional columns related to the crop yield calibration function in WEPS. When the columns are displayed, the '**Yield Calibrate**' button is outlined in red  .

b) Within MCREW, select the crop (or crops) that you want to calibrate by setting the '**Yield Calib. flg**' column value to '**1**' for the respective row the crop planting operation is in. Be sure to "tab" or press "enter" after putting that number in the cell to 'register' the flag.

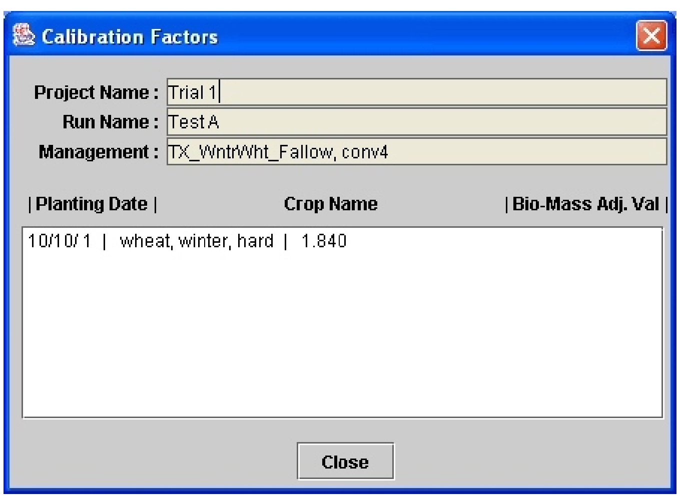
c) Fill in the desired '**Target Yield**' for the selected crop(s). Note that the units and the moisture content this yield will be reported in are displayed. (Do NOT change the yield units or yield water content values. Doing so will not have the desired affect within the model at this time. In the future, we expect that this functionality might be made available to the end user). Again, be sure to "tab" or press "enter" after entering the desired target yield value into the cells.

NOTE: More than one crop can be selected for simultaneous yield calibration. However, the algorithms used do not guarantee that a solution will be found when multiple crops are specified for calibration. In practice though, we have found it to work well in most situations.

d) Save the rotation management file in MCREW. Currently, this can be done by: i) pressing the '**Save**' icon , ii) via the '**File** > **Save**' menu option, or iii) using the '**Ctrl-S**' keyboard shortcut.

e) Exit MCREW. This can be done either by: i) clicking on the "close" button in the top right corner of the MCREW window frame or ii) via the '**File** > **Exit**' menu option. Note that if one forgets to save the management file before attempting to exit MCREW, the user will be notified and given the opportunity to do so before exiting MCREW.

f) Click the '**Make a Yield Calibration WEPS Run**' via the '**Run**' menu option on the main screen (Fig. 2.14). The shortcut '**Ctrl-C**' will also work if the main WEPS screen has focus.



g) After the Calibration Run has completed, a popup dialog window will appear that displays the '**Calibration Factors**' for each crop selected for calibration (see figure to the left). One can then enter these values back into the management file using MCREW - (remember to press the yield calibration button to display the extra crop calibration parameter columns). For each crop that had been "calibrated", enter the new values into the '**Biomass Adj. Factor**' column. The biomass adjustment factor determined for each crop is also written into the 'notes' file for the calibration run.

h) To save these changes into a "newly calibrated" crop record file, one must use the "drilldown" feature in the appropriate crop cell to display the list of crop parameters. The user can then save these parameter values to a new "crop record" file using the '**Save As**' function. Appropriately rename the newly calibrated crop record. Once saved, the user can then select and insert that crop record into any WEPS management file using MCREW.

Restore a WEPS Run

A previously created WEPS run can be restored by clicking on the '**Run**' menu and selecting '**Restore a WEPS Run**' (Fig. 2.14). This will open a file chooser that allows the user to select a previously created WEPS run. Alternatively, one can click the restore button , to restore a run. The restored run will then be the current project. It can be modified and run again with a new run name. The new run will be saved in a new subdirectory; previous WEPS runs cannot be overwritten. Runs can be removed (i.e., deleted) from your computer using a file manager such as Windows Explorer (not provided with WEPS). It is recommended that the user remove unwanted runs regularly to prevent these runs from filling the hard disk space.

Viewing Previous Outputs

Output from either the current run or previous runs can be viewed using the '**ViewOutput**' menu (Fig 2.14). This menu allows the user to view output for the current or previous runs. Clicking on the '**Current Run**' menu item displays a list of output reports for the current (last completed WEPS simulation) run. Clicking on the '**Previous Run**' menu item displays list of output reports for previous runs. For previous runs, a file chooser opens to allow the user to pick the desired run for which to view the output. See the section of the WEPS User Manual titled '**Output**' for more detailed description of WEPS outputs.

Errors

If an error occurs during a WEPS simulation run, an error message will appear. Once the error message is closed, an e-mail window opens that allows the user to report the error to USDA-ARS Wind Erosion Research Unit (Fig. 2.16). The user should enter an e-mail address and a short message. Click the appropriate box at the bottom of the window to attach either the current project (with all associated run directories) or the current run files to your e-mail. Typically, one would only attach the run unless there is a specific reason to attach the project and all its associated run directories. Because of the number of potential files within a project, attaching a project could create a large size attachment. Note, that by default the project is attached to the e-mail message. If you are connected to the Internet, clicking '**Send**' will e-mail the message to WERU, along with any attached files, so that your inquiry can be answered. Also note that the user cannot send e-mail from WEPS unless they have correctly configured the WEPS e-mail client within the ‘**Configuration**’ window.

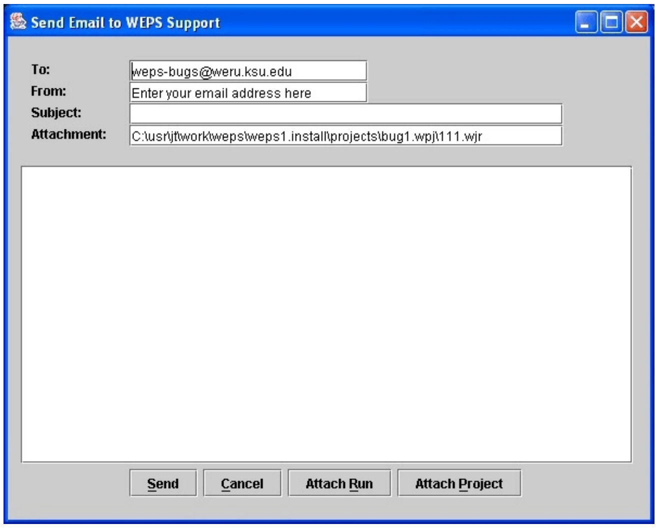


Figure 2.16. E-mail error report window.

WEPS Output

WEPS provides numerous outputs to aid the user in conservation planing. These outputs are accessed through the '**ViewOutput**' menu on the main screen. Clicking on this menu displays two choices, '**Current Run**' and '**Previous Run**'. Clicking on '**Current Run**' displays a list of output options for the current run. The 'Previous Run' choice allows the user to view results of previous runs. A description of the choices under these two submenus follow.

Project Summary

The Project Summary report screen (Fig. 2.17) will automatically display at the conclusion of a simulation run. If the Project Summary screen has been closed, the user can display the Project Summary screen for the current project or previously run projects by clicking the '**ViewOutput**' menu on the WEPS main screen menu bar.

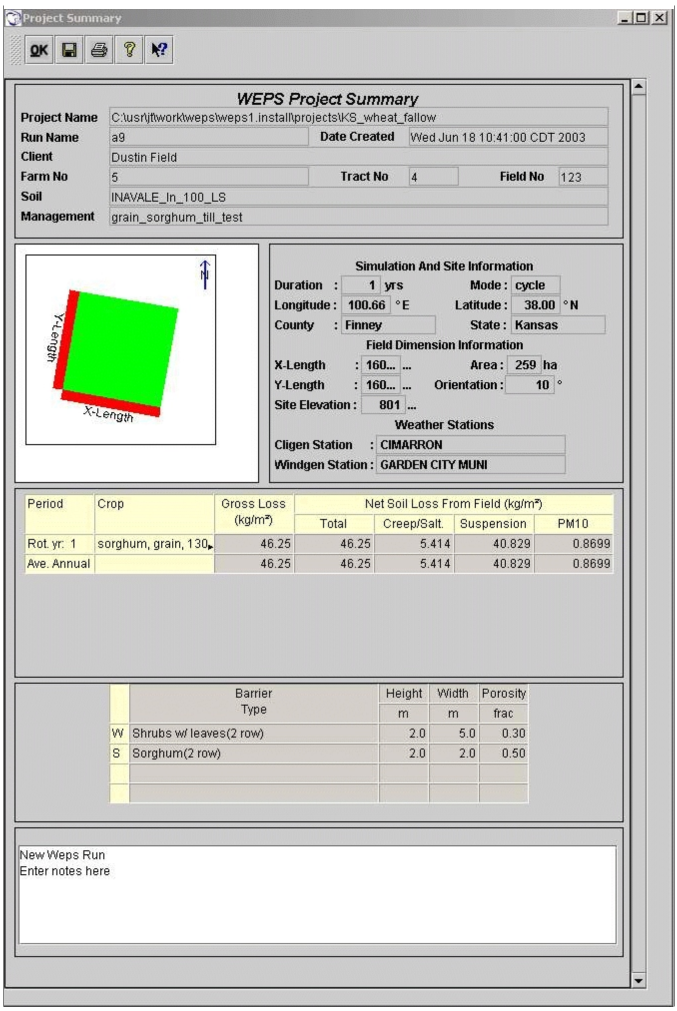


Figure 2.17. The WEPS Project Summary screen.

The Project Summary contains names of the input files as well as other input parameters and basic soil loss information by rotation year and the average annual for the total simulation.

Soil loss output in the Project Summary includes: **Gross Loss** which is the average erosion within the field; **Total** which is the average total net loss from the field; **Creep/Salt** which is the average creep plus saltation net loss from the field; **Suspension** which is the average suspension net loss from the field; and **PM10** which is the average PM10 net loss from the field. If any barriers were present on the field borders, a summary of their properties is also listed. Finally, any notes entered on the main screen for the run are reproduced and they can be edited or added to if desired.

A button bar is included at the top of the Project Summary screen which allows the user to close the window, save the notes to the summary, print the summary, open general help for the summary, and use the context help.

Crop Summary

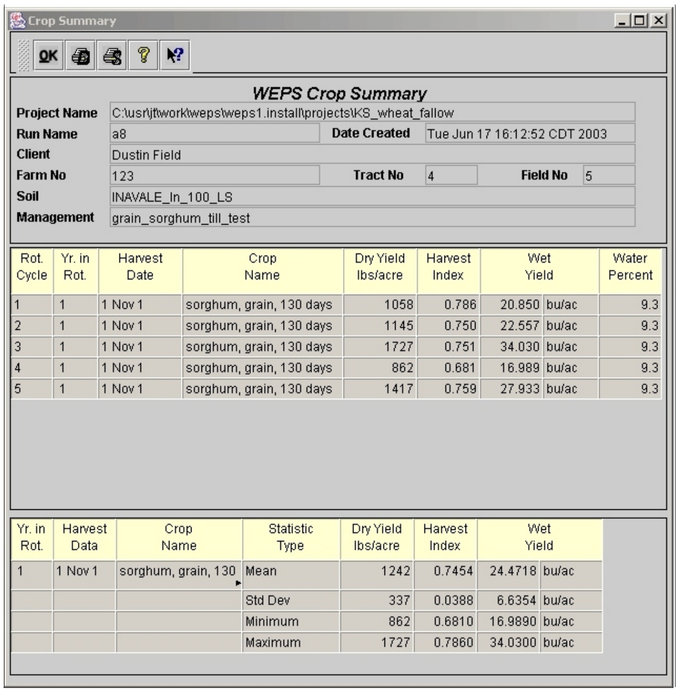


Figure 2.18. The WEPS Crop Summary screen.

The Crop Summary report screen (Fig. 2.18) contains simulation run information including the names of the input files. It also contains a Detailed Report table and a Summary Report table for each crop grown during the simulation run.

The Detailed Report table gives crop yield data for each crop year in the simulation. The Summary Report table provides statistical summary parameters for each rotation year. For example, it gives the mean yield for all the simulation years that an individual crop was grown.

A button bar is included at the top of the screen which allows the user to close the window, print the crop detail table, print the crop summary table, open general help for the WEPS, and use the context help.

Management Summary

The Management Summary report screen contains simulation run information including names of the input files.

A button bar is included at the top of the Management Summary screen which allows the user to close the window **OK**, print the management summary, open general help for the WEPS, and use the context help.

Detail Reports

The Detailed Reports screen (Fig. 2.19) provides a choice list where the user can select various types of output. The features of the Detailed Reports Screen are described below.

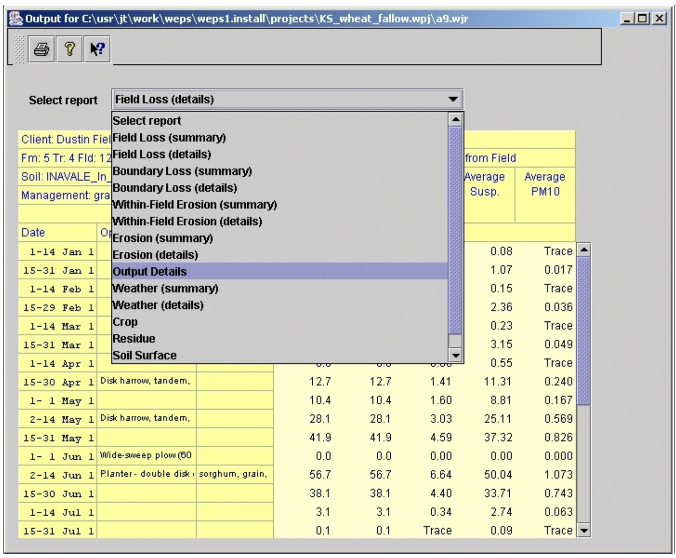


Figure 2.19. The WEPS Detailed Reports screen showing the drop down report list.

A button bar is included at the top of the Detailed Reports screen which allows the user to close the window **OK**, print any detail report, open general help for the WEPS, and use the context help. Below the button bar is a drop down report list labeled '**Select report**'. Clicking the down arrow to the right of '**Select report**' displays the list of output available. Click the desired list and it will be displayed in the window below. The following is a description of each report screen.

<u>Output Details</u>

The Output Details report contains all of the erosion, weather, and surface information available by period, by rotation year, and for the entire simulation run.

The columns of the Output Details report have the following information.

Date -This column contains the start and end dates (day/month/rotation year) of the reporting period.

Operation - This column contains the management operation which occurred on the specified date.

Wind Erosion

Average Total Gross Soil Loss - The Average Total Gross Soil Loss is the average erosion within the field, averaged across the field as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Net Soil Loss from Field

Average Total - The average total net loss from the field(kg/m^2 or tons/acre).

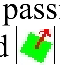
Average Creep/Sal. - This column contains the total creep plus saltation net loss for the period, averaged across the field grid areas, as well as averaged over the number of simulation years in each year of the crop rotation (kg/m^2 or tons/acre).

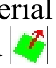
Average Susp. - This column contains the total suspension net loss for the period, averaged across the field grid areas as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Average PM10 - This column contains the net PM10 soil loss for the period, averaged across the field grid areas as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Mass of Soil Passing Indicated Field Boundary

Creep+Saltation - These columns display the average mass of creep plus saltation size material passing each field boundary (kg/m or tons/1000 ft) in the direction indicated  .

Suspension - These columns display the average mass of suspension size material passing each field boundary (kg/m or tons/1000 ft) in the direction indicated  .

PM10 - These columns display the average mass of PM10 (particulate matter less than 10 microns) size material passing each field boundary (kg/m or tons/1000 ft) in the direction indicated  .

Within Field Wind Erosion Activity

The information in this section is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any should be applied and where. This information is also useful in understanding how much of the field is actively eroding and thus may be causing plant or soil damage or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Saltation Emission Region

Soil Loss - This column displays the amount of soil loss from that area of the field that had saltation emission (kg/m^2 or tons/acre).

Field Area - These columns display both the area (acres or hectares) and fraction of that area of the field that had saltation emission.

Deposition Region

Soil Deposition - This column displays the amount of soil deposited in that area of the field where deposition is the primary activity (kg/m^2 or tons/acre).

Field Area - These columns display both the area (acres or hectares) and fraction of that area of the field that had deposition.

High Flux Region

Field Area - These columns display both the area (acres or hectares) and fraction of that area of the field which was near transport capacity.

Sheltered Region

Field Area - These columns display both the area (acres or hectares) and fraction of that area of the field that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers.

Weather Info

Average Total Period Precip - This column contains the total precipitation for the period averaged over the simulation years in each year of the crop rotation (mm or inches).

Average Wind Energy >8 m/s - This column contains the average daily wind energy for the period for winds greater than 8 m/s, averaged over the simulation years in each year of the crop rotation (KJ/day).

Average Snow Cover > 20 mm - This column contains the total average fraction of time that snow cover on the field which is greater than 20 mm in depth (mm or inches).

Average Biomass Surface Conditions on Date

Crop Vegetation (Live)

Canopy Cover - This column contains the fraction of live crop biomass cover (vertical view) at the period end, averaged over the simulation years for the period listed (fraction).

Effective Standing Silhouette - Effective standing silhouette is the standing silhouette area index of live plants expressed on a fraction basis. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. These are values at the period end averaged over the simulation years in each rotation year.

Above Ground Mass - This column contains the total live crop biomass, above ground, at the period end, averaged over the simulation years for the period listed (kg/m^2 or lbs/acre).

Crop Residue (Dead)

Flat Cover - This column contains the amount of flat dead cover on the soil surface, expressed as a fraction. These are values at the period end averaged over the simulation years in each rotation year (fraction).

Effective Standing Silhouette - Effective standing silhouette is the standing silhouette area index of dead plants expressed on a fraction basis. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. These are values at the period end averaged over the simulation years in each rotation year.

Flat Mass - This column contains the amount of flat dead biomass on the soil surface. These are values at the period end averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Standing Mass - This column contains the amount of standing dead biomass on the soil surface. These are values at the period end averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Live and Dead Biomass

Flat Cover - This column contains the amount of flat cover from live (canopy cover) and dead (flat cover) biomass on the soil surface expresses on a fraction basis. These are values at the period end averaged over the simulation years in each rotation year (fraction).

Standing Silhouette - Effective standing silhouette is the standing silhouette area index of live plus dead plants. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. These are values at the period end averaged over the simulation years in each rotation year (fraction).

Flat Mass - This column contains the amount of flat live (air dried) and dead biomass on the soil surface. These are values at the period end averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Standing Mass - This column contains the amount of standing live and dead biomass. These are values at the period end averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Average Soil Surface Conditions on Date

Oriented Roughness

Ridge Orientation - This column contains orientation of the ridges with zero degrees (0°) representing north/south ridges.

Ridge Height - This column contains the height of ridges. This is the value at the period end averaged over the simulation years in each rotation year (mm or inches).

Ridge Spacing - This column contains the spacing between ridges. This is the value at the period end averaged over the simulation years in each rotation year (mm or inches).

Random Roughness - This column contains the standard deviation of the soil surface random roughness. This is the value at the period end averaged over the simulation years in each rotation year (mm or inches).

Aggregation

Aggregates > 0.84 mm - This column lists the fraction of aggregates greater than 0.84 mm. Aggregates > 0.84 mm are generally considered to be non-erodible. This is the value at the period end averaged over the simulation years in each rotation year.

Aggregate Stability - This column lists aggregate stability which is the log of crushing energy of dry soil aggregates (ln(J/kg)) and is related to abrasion resistance. This is the value at the period end averaged over the simulation years in each rotation year.

Crust Cover - This column lists the fraction of the soil surface that is crusted. This is the value at the period end averaged over the simulation years in each rotation year.

The **rows** in the Output Details table vary depending on the number of cropping years in the rotation and the number of management operations in each year of the rotation.

Each year of the rotation has output displayed for the two week periods as well as for each management operation date. This output allows the user to view the erosion and other output for each year of the rotation. At the end of each year in the rotation is a row which contains the average annual value for that rotation year.

The last row in the output form contains the average annual values for the complete crop rotation.

The remaining menu list items on the Detail Reports screen follow and are generally a subset of the Output Detail menu option described above.

<u>Field Loss (summary)</u>
The Field Loss summary report displays average soil loss by rotation year and for the entire simulation run. The values displayed include: Average Total Gross Soil Loss which is the average erosion within the field; Net Average Total which is the average total net loss from the field; Net Average Creep/Salt which is the average creep plus saltation net loss from the field; Net Average Suspension which is the average suspension net loss from the field; and Net Average PM10 which is the average PM10 net loss from the field.

<u>Field Loss (details)</u>
The Field Loss detailed report displays average soil loss by period, by rotation year, and for the entire simulation run. The values displayed include: Average Total Gross Soil Loss which is the average erosion within the field; Net Average Total which is the average total net loss from the field; Net Average Creep/Salt which is the average creep plus saltation net loss from the field; Net Average Suspension which is the average suspension net loss from the field; and Net Average PM10 which is the average PM10 net loss from the field.

<u>Boundary Loss (summary)</u>
The Boundary Loss summary report displays the average mass passing each field boundary (kg/m or tons/1000 ft) in the direction indicated . These parameters are reported for each rotation year and for the simulation run. The columns labeled 'Creep + Saltation' contain the mass per unit boundary length of creep plus saltation size material which passed the field boundary for each direction. The Suspension columns contain the mass per unit boundary length of suspension size material which passed the field boundary for each direction. The

PM10 columns contain the mass per unit boundary length of PM10 size material which passed the field boundary for each direction.

Boundary Loss (details)

The Boundary Loss detailed report displays the average (by period, rotation year, and simulation run) mass passing each field boundary (kg/m or tons/1000 ft) in the direction indicated . These parameters are reported by period, for each rotation year, and for the simulation run. The columns labeled 'Creep + Saltation' contain the mass per unit boundary length of creep plus saltation size material which passed the field boundary for each direction. The Suspension columns contain the mass per unit boundary length of suspension size material which passed the field boundary for each direction. The PM10 columns contain the mass per unit boundary length of PM10 size material which passed the field boundary for each direction.

Within-Field Erosion (summary)

The Within-Field Erosion summary report displays information for various types of erosion activity by rotation year and for the simulation run. These activities include amounts as well as area and fraction of the field which had saltation emission and deposition. In addition high flux and sheltered area and fraction of the field are given. The high flux region is that area which is near transport capacity. A sheltered area is one that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers. This information is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any should be applied and where. This information is also useful in understanding how much of the field is actively eroding and thus may be causing plant or soil damage or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Within-Field Erosion (details)

The Within-Field Erosion detailed report displays information for various types of erosion activity by period, by rotation year and for the simulation run. These activities include amounts as well as area and fraction of the field which had saltation emission and deposition. In addition high flux and sheltered area and fraction of the field are given. The high flux region is that area that is near transport capacity. A sheltered area is one that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers. This information is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any should be applied and where. This information is also useful in understanding how much of the field is actively eroding and thus may be causing plant or soil damage or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Erosion (summary)
The erosion summary report displays all of the information available on erosion contained in the sections above labeled Field Loss (summary), Boundary Loss (summary), and Within-Field Loss (summary).

Erosion (details)
The erosion detailed report displays all of the information available on erosion contained in the sections above labeled Field Loss (details), Boundary Loss (details), and Within-Field Loss (details).

Weather (summary)
The weather summary report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field which is greater than 20 mm. These parameters are reported for each rotation year and for the simulation run.

Weather (details)
The weather detailed report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field which is greater than 20 mm. These parameters are reported by period, for each rotation year and for the simulation run.

Crop (details)
The crop report displays average live above ground biomass conditions that existed on the end date for the period reported. The conditions displayed includes canopy cover, effective standing silhouette, and above ground mass. Canopy cover is the fraction of live crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of live plants. These values are standing silhouette area per area of soil surface expressed as a fraction. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Above ground mass is the total above ground biomass.

Residue (details)
The residue report displays average dead above ground biomass conditions that existed on the end date for the period reported. The conditions displayed includes flat cover, effective standing silhouette, flat mass, and standing mass. Flat cover is the fraction of dead crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of dead plants. These values are standing silhouette area per area of soil surface expressed as a fraction. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Flat mass is the above ground biomass that is lying flat on the soil surface. Standing mass is the above ground biomass that is in a standing or upright position on the soil surface.

Biomass (details)
The biomass report displays average live plus dead above ground biomass conditions that existed on the end date for the period reported. The conditions displayed includes flat cover, effective standing silhouette, flat mass, and standing mass. Flat cover is the fraction of live plus dead crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of live plus dead plants. These values are standing silhouette area per area of soil surface expressed as a fraction. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Flat mass is the above ground biomass that is lying flat on the soil surface. Standing mass is the above ground biomass that is in a standing or upright position on the soil surface.

Soil Surface (details)
The soil surface report displays average soil conditions at the surface that existed on the end date for the period reported. The conditions displayed includes ridge orientation, ridge height, ridge spacing, random roughness, aggregates greater than 0.84 mm, aggregate stability, and crust cover. Ridge orientation is the orientation of the ridges with zero degrees (0°) representing north/south ridges. Random roughness is the standard deviation of the soil surface roughness height. Aggregates greater than 0.84 mm are expressed as a fraction and are those aggregates generally considered to be non-erodible. Aggregate stability is the log of crushing energy of dry soil aggregates (ln(J/kg)).

Surface Conditions (details)
The surface conditions detailed report displays all of the information available on the field surface contained in the sections above labeled Crop, Residue, Biomass, and Soil Surface.

Raw Output

The Raw Output report screen provides a means of accessing output files of WEPS. A list of selectable output files are available on the dropdown list labeled “Select file to display”. These files are generally for advanced users and model developers. For more information on accessing and interpreting the raw output files, contact WERU.

A button bar is included at the top of the Raw Output screen which allows the user to close the window , print the opened file , open general help for WEPS , and use the context help .

USING WEPS IN CONSERVATION PLANNING

Interpreting Outputs

Interpreting outputs of WEPS is an important part of controlling wind erosion through conservation planning. By observing how the soil loss is affected by weather and field conditions, the management operations can be adjusted to reduce soil loss. In developing new conservation plans, the user should build or modify several different scenarios and compare outputs to determine the best management to control wind erosion. Because of runtime issues, it is recommended that, for early comparisons, no more than five rotations cycles be used for a simulation. This will allow relative soil loss values for comparisons. Once one or two scenarios are selected, more rotation cycles are recommended for more accurate erosion loss estimates. The number of erosion cycles can be set by selecting "Configuration" then "WEPS Developers Options" menus on the main screen.

The following section outlines the content of the "Output Details" screen.

Date
This column contains the start and end date of the period for which the row information is reported (start day-end day month rotation year). Items in each row represent values from the end of the previous period to the current date. The date column, along with soil loss, will indicate which periods have the greatest wind erosion and are thus in need of changes of management to control wind erosion.

The **rows** in the Output Details screen vary depending on the number of cropping years in the rotation and the number of management operations in each year of the rotation. Each year of the rotation has output displayed for the first two weeks and the 15th to the last day of each month as well as for each management operation date. This output allows the user to view the erosion and other output for each year of the rotation. At the end of each year in the rotation is a row which contains the average annual value for that rotation year. The last row in the output form contains the average annual values for the complete crop rotation.

Operation
This column contains the management operation which occurred on the specified date. It is the management operation or the date of operation which most users will modify to affect field conditions and thus wind erosion.

Crop
This column lists any crops planted on the date shown. Crop is obviously another choice which the land manager may change to control wind erosion.

Wind Erosion
The Wind Erosion columns provide a summary of all the wind erosion soil loss for the simulation run. The numbers in these columns are those that the user will try to affect by

adjusting management dates and operations. If an erosion event occurred but values generated by the model are too small to be displayed on the output table (e.g. < 0.001 kg/m^2), then the amount is listed as “trace”. If amounts are to large to be accurately displayed then the amount is listed simply as greater than a specified amount (i.e., > 300 kg/m^2). In these cases erosion amounts are so large that they are generally unacceptable.

Average Total Gross Soil Loss
This column contain the gross erosion within the field, averaged across the field as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Net Soil Loss from Field
These columns contain net soil loss from the field averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre). Some deposition within a field can occur especially when barriers are present downwind. Net soil loss is the amount of gross loss minus deposition. Total is the average total net loss from the field; Creep/Sal is the average creep plus saltation net loss from the field; Susp is the average suspension net loss from the field; and PM10 is the average PM10 net loss from the field.

Mass Passing Indicated Field Boundary
These columns  contain the mass per unit length of various sized material which passed the field boundary for each direction (kg/m or tons/1000 ft). This information is useful in determining how much material is leaving the field in each direction. For the creep/saltation size, the material will most likely be deposited on the field boundary such as a stream, fence, ditch, or road. If deposited in a ditch, subsequent rainfall way wash the material in to waterways where it can affect water quality. If deposited on a roadway, the roadway will likely need to be cleared. For suspension and PM10 sizes, the material may travel great distances affecting air quality. The material passing each boundary may indicate that barriers may be needed on the opposite or upwind side of the field to control wind erosion. The direction of soil loss may also indicate a needed change in direction of tillage.

Within Field Wind Erosion Activity
The information in these columns is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any should be applied and where. This information is also useful in understanding how much of the field is actively eroding and thus may be causing plant or soil damage or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Weather
The Weather columns provide a summary of some of the weather information for the simulation run and help the user understand which periods are erosive and why.

Average Total Precip.
This column contains the total precipitation for the period averaged over the simulation years in each year of the crop rotation (mm or inches). This section is useful in determining how precipitation amounts may be affecting biomass production and roughness decay.

Average Wind Energy > 8m/s
This column contains the average daily wind energy for the period for winds greater than 8 m/s, averaged over the simulation years in each year of the crop rotation (KJ/day). This will indicate which periods have the most erosive winds.

Average Snow Cover
If the field is covered with snow, it will be non-erodible.

Average Biomass Surface Conditions on Date
The Average Surface Biomass Conditions on Date columns provide a summary of average surface conditions including crop biomass and soil roughness for the simulation run.

Crop Vegetation (Live)
These columns provide information on the structural configuration of live growing biomass. By observing the canopy cover, the standing silhouette area index, and the above ground mass, the user can determine which periods are not providing sufficient cover to control wind erosion.

Crop Residue (Dead)
These columns provide information on the structural configuration of dead biomass or residue. By observing the flat cover, the standing silhouette area index, the flat mass, and the standing mass, the user can determine which periods are not providing sufficient residue cover to control wind erosion.

Live and Dead Biomass
These columns provide information on the structural configuration of both the live growing biomass and the dead biomass or residue. By observing the flat cover, the standing silhouette area index, the flat mass, and the standing mass, the user can determine which periods are not providing sufficient cover to control wind erosion.

Average Soil Surface Conditions on Date
Roughness
For cropping systems that do not produce sufficient residue for erosion control (e.g., cotton), roughness management is often used to reduce wind friction velocity at the soil surface. This reduces the amount of soil detachment and transport and increases deposition and thus soil loss.

Ridge Orientation
These columns refer to regularly spaced roughness elements caused by tillage implements such as ridges, furrows and dikes. Ridge orientation, width, and height may be adjusted for periods of high soil loss to determine its effect on wind erosion. The user can also follow the roughness decay over time as result of rainfall.

Random Roughness
This column contains the standard deviation of the soil surface random roughness. This is the value at the period end, averaged over the simulation years in each rotation year (inches or mm). Random roughness is primarily the result of aggregate size distribution but is also affected by various types of tillage tools. Random roughness values for typical management operations are listed in Table 3.0. Photographs (Figs. 3.0 - 3.8) can be used as a guide to determine relative random roughness values.

Aggregation
Soil aggregate size and aggregate dry stability affect erosion by wind. Soil aggregates greater than 0.84 mm in diameter are generally considered to be non-erodible. Dry stability is related to abrasion resistance where harder, more stable aggregates result in a lower erodibility of the soil.

Crust Cover
A soil crust will resist abrasion and erosion more than a loose finely divides soil surface. Generally, the more of the surface is covered by a crust, the lower the erosion that occurs. Crust are transient and generally represent a degraded soil quality and therefore should not be relied upon to control erosion by wind. However a high crust cover may explain a lower erosion amount that would normally be expected.

Table 3.1. Random roughness values for typical management operations based on a silt loam soil (Ag. Handbook 537).

Field Operation	Random Roughness (inches)	Field Operation	Random Roughness (inches)
Chisel, sweeps	1.2	Fertilizer applicator, anhydrous knife	0.6
Chisel, straight point	1.5	Harrow, spike	0.4
Chisel, twisted shovels	1.9	Harrow, tine	0.4
Cultivator, field	0.7	Lister	0.8
Cultivator, row	0.7	Manure injector	1.5
Cultivator, ridge till	0.7	Moldboard plow	1.9
Disk, 1-way	1.2	Mulch threader	0.4
Disk, heavy plowing	1.9	Planter, no-till	0.4
Disk, Tandem	0.8	Planter, row	0.4
Drill, double disk	0.4	Rodweeder	0.4
Drill, deep furrow	0.5	Rotary hoe	0.4
Drill, no-till	0.4	Vee ripper	1.2
Drill, no-till into sod	0.3		

Figure 3.0. Random roughness of 0.25 inches (6 mm).

Figure 3.1. Random roughness of 0.40 inches (10 mm).

Figure 3.2. Random roughness of 0.65 inches (17 mm).

Figure 3.3. Random roughness of 0.75 inches (19 mm).

Figure 3.4. Random roughness of 0.85 inches (22 mm).

Figure 3.5. Random roughness of 1.05 inches (27 mm).

Figure 3.6. Random roughness of 1.60 inches (41 mm).

Figure 3.7. Random roughness of 1.70 inches (43 mm).

Figure 3.8. Random roughness of 2.15 inches (55 mm).

Special Field Configurations

Although WEPS 1.0 is designed to simulate rectangular field shapes, special field configurations such as circles or strip cropping can be simulated. By manipulating the field shape to represent a field with the same area and rotating the field along with any barriers many field shapes can be approximated.

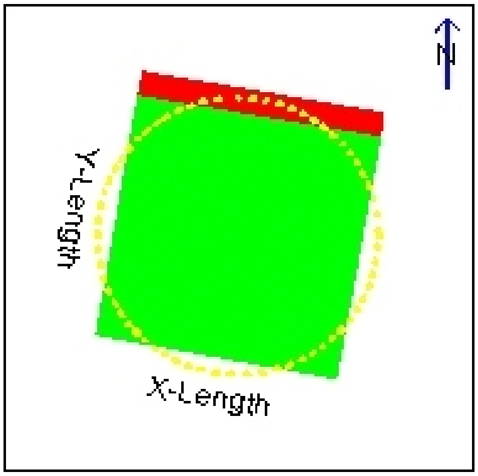


Figure 3.9. Example of using a square field shape to approximate a circle.

Circular Fields. A circular field can be simulated using a square field of equal area. Figure 3.9 illustrates how this would be visualized. Note that the yellow dashed circle is shown here to illustrate the circular field and cannot be placed over the field within the WEPS 1.0 interface. For such fields, barriers should be added and the field rotated to best simulate the actual field configuration.

Irregular Field Shapes. Other field shapes can also be simulated with WEPS 1.0. A half circle can be represented with a rectangle as illustrated in Figure 3.10. Figure 3.11 illustrates how an irregular field may be visualized for a filed along a stream with filter strips along the North and East sides.

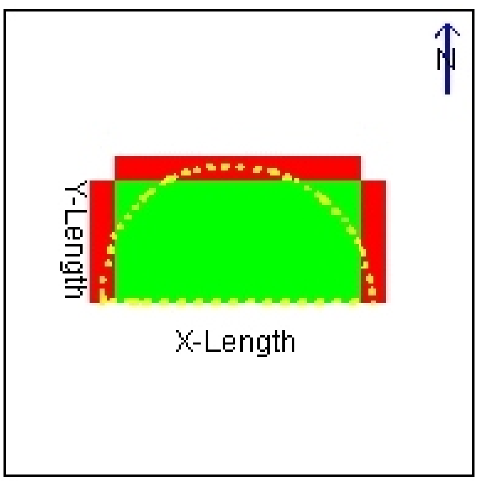


Figure 3.10. Example of using a rectangular field to simulate a half circle.

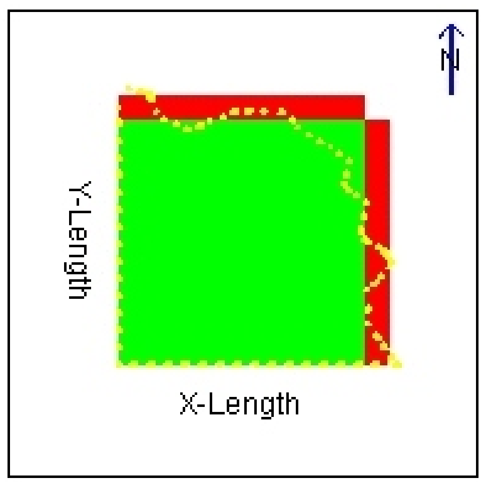


Figure 3.11. Example of using a square field to simulate a field with a stream with buffers along two sides.

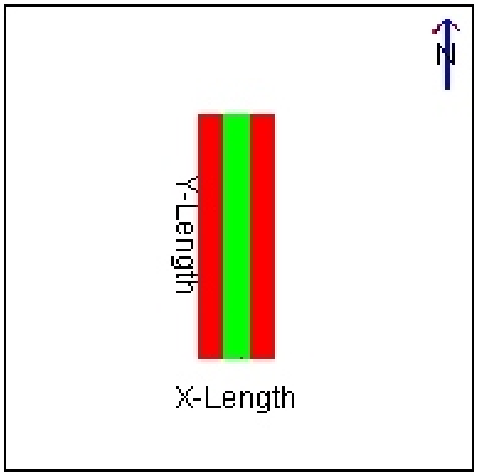


Figure 3.12. Example field layout for simulating strip cropping or grass barriers.

Strip Cropping. Fields managed for wind erosion control by strip cropping in WEPS 1.0 are simulated as linear strips, with each strip of unique management as an individual rectangular field and the erosion losses for each unique strip multiplied by the number of those strips. Ideally, a tract of land where strips are installed will be equally stripped, thus shorting the width of the field along the most erosive winds. The field will be resized down to the strip width that a producer agrees with or to other widths for demonstration purposes. We can change the field size by just typing in the field dimensions. See the section "Describing the Field and Barriers" for more details on adding and modifying field barriers. Figure 3.12 illustrates a field layout for simulating strip cropping or grass barriers.

Tillage Direction. WEPS 1.0 only allows tillage in one direction (e.g., Northwest/Southeast). In other words, multiple tillage directions such as where the operator tills parallel to each border of the field or a circular tillage pattern, cannot be simulated with WEPS 1.0. Observing the effects that tillage direction may have for the particular simulation may illustrate the need to alter tillage directions in the actual field to control wind erosion.

Using Barriers for Erosion Control in WEPS

Using WEPS, we can quickly determine the field edge where the greatest amount of eroded soil is leaving the field. In most cases, a field windbreak would be most effective on the upwind side of this field.

Wind barriers in WEPS include any structure designed to reduce the wind speed on the downwind side of the barrier. Barriers trap moving soil and reduce abrasion of the downwind immobile clods, crusts, and residues along the prevailing wind erosion direction. Barriers include but are not limited to, linear plantings of single or multiple rows of trees, shrubs, or grasses established for wind erosion control, crop protection, and snow management. Snow fences, board walls, bamboo and willow fences, earthen banks, hand-inserted straw rows, and rock walls have also been used as barriers for wind erosion control in limited situations. Barriers also reduce evapotranspiration, shelter livestock, and provide wildlife habitat. One advantage of barriers over most other types of wind erosion control is they are relatively permanent. During drought years, barriers (excepting annual types) may be the only effective and persistent control measure on crop land. Annual barriers are used primarily to provide temporary protection during the most critical wind erosion period and can be removed and replaced every year. Barriers can also be used in sand dune areas to aid the initial stabilization of the areas while grass and trees are being established.

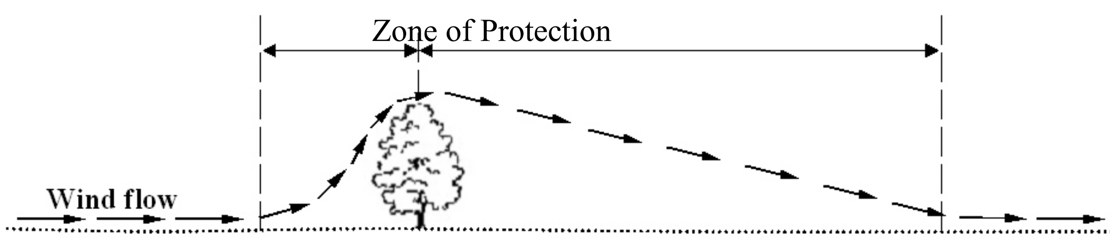


Figure 3.13. Diagram showing wind flow pattern over a barrier.

Barriers primarily alter the effect of the wind force on the soil surface by reducing wind speed on the downwind side of the barrier but also reduce wind speed to a lesser extent upwind of the barrier (Fig 3.13). Research has shown that barriers significantly reduce wind speed downwind, sheltering a portion of the field from erosion and in effect, reducing the field length along the erosive wind direction. However, the protected zone of any barrier diminishes as porosity increases and is reduced significantly when barrier porosity exceed 60 percent. Protection is also reduced as wind velocity increases but the protected area diminishes as the wind direction deviates from the perpendicular to the barrier. Various types of barriers are used for wind erosion control in WEPS 1.0. The WEPS interface provides a method of selecting from a list of barriers to place on the field and editing the barrier properties. The user can also modify properties in the barrier database that appear in the drop down list. Each of these properties are described below.

The length of a barrier is defined by field length along the border on which the barrier is placed.

Width The width of a barrier is defined as the distance from one side of the barrier to the other, in the units of measure displayed on the screen (feet or meters) (Fig. 3.14). For a single row wind barrier, the width is equal to the diameter of the tree, shrub, or grass, or for artificial barriers, the thickness of the material (e.g. slat fence). This is illustrated as "a" in Fig. 3.14. For multiple row barriers, the width is the distance from one side of the barrier to the other as illustrated by "b" in Fig. 3.14.

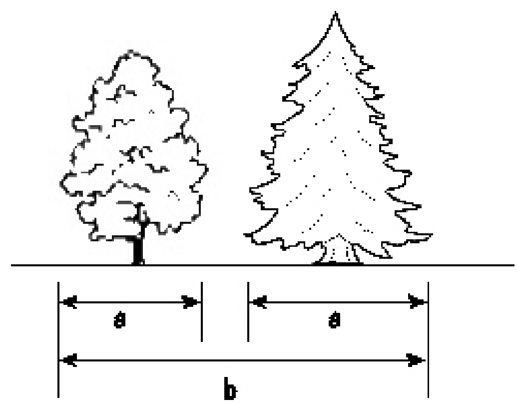


Figure 3.14. Barrier width for single (a) and multiple (b) row barriers.

Height The height of a barrier is the average height of individual elements (e.g. trees) in the barrier ("a" in Fig. 3.15 for single row barriers). The units of measure for barrier height are displayed on the input screen in feet or meters. For multiple row barriers, use the height of the tallest barrier row ('b" in Fig. 3.15).

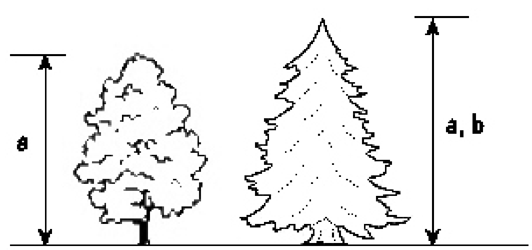


Figure 3.15. Barrier height for single (a) and multiple (b) row barriers.

Area The area of the barrier is calculated from the barrier width and length (i.e., barrier width x field length). This is not an editable item, but is calculated within WEPS 1.0.

Porosity Barrier porosity is defined as the total optical porosity of all rows in the barrier. It is the open space (i.e., absence of leaves and stems) as viewed looking perpendicular to the barrier, expressed as a percent of the total area (ie., (1.0 - silhouette area) x 100). WEPS 1.0 does not "grow" living barriers.

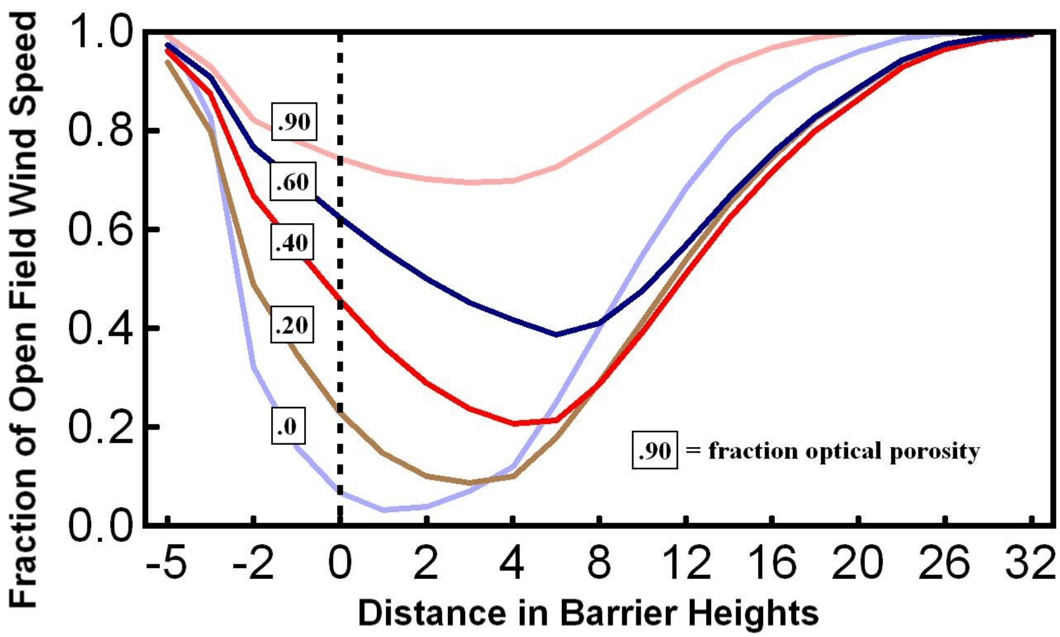


Figure 3.16. Effect of the fraction of optical porosity on near surface wind speed along the wind direction relative to barrier.

They do not increase or decrease porosity with leaf growth and leaf drop (senescence), nor do they increase in size from one year to the next. As such, the porosity of barriers in WEPS does not change with the seasons nor from year to year. Therefore the user should input the porosity of the barrier that is present when the erosion hazard is the greatest. Figure 3.16 illustrates the effect of porosity on the near surface wind speed relative to an open field without a barrier.

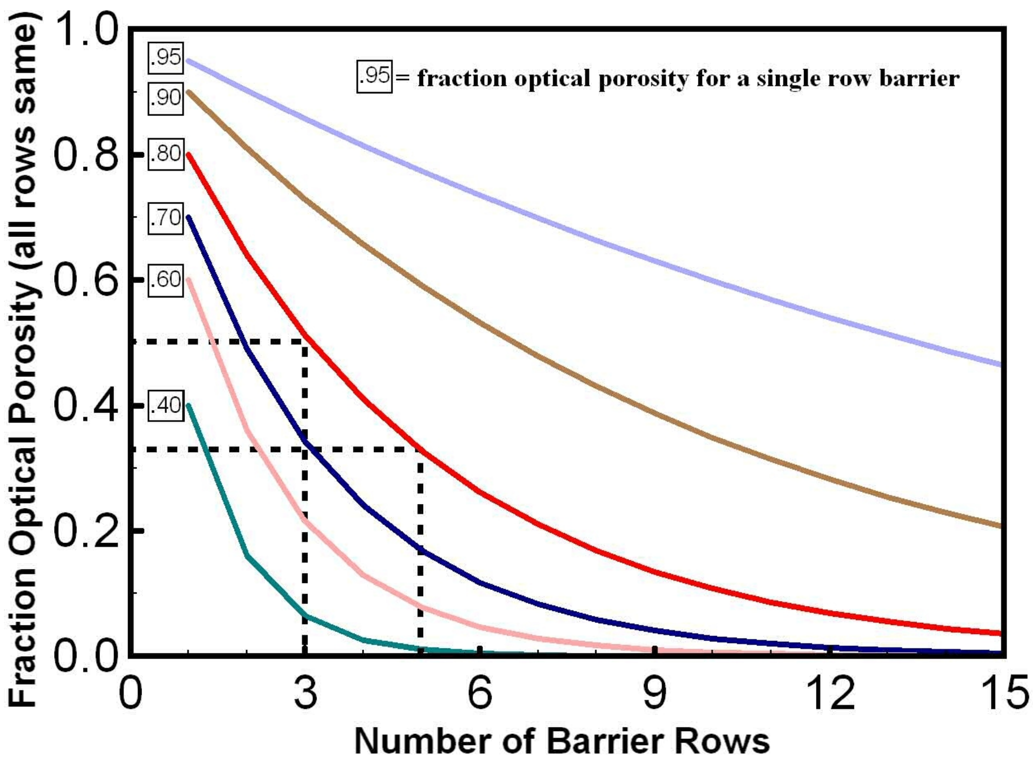


Figure 3.17. Effect of number of barrier rows on optical porosity where all barrier rows are the same.

At times, it is most efficient to estimate optical porosity for a single row, particularly for crop barriers. Then for multiple row barriers, the optical porosity decreases for the entire barrier as illustrated in Figure 3.17. For example, a single row of corn has an optical porosity of 0.80. Three rows of corn have an optical porosity of 0.50 while five rows of corn have an optical porosity of 0.33.

Exercises

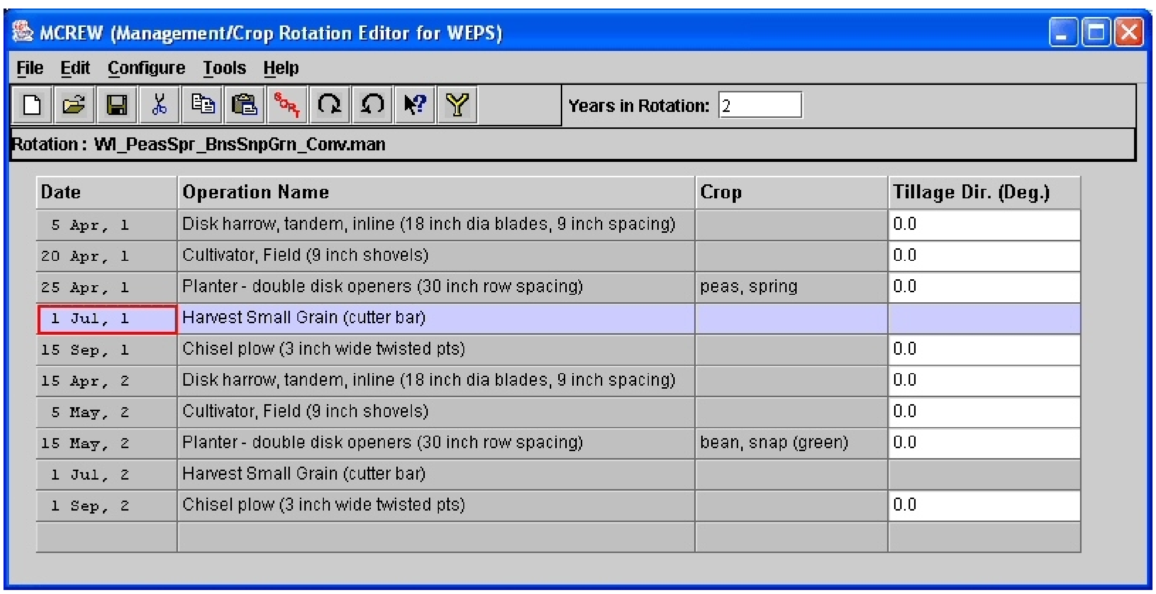
EVALUATING WIND EROSION PROBLEMS WITH WEPS

This is an example problem that we will use to evaluate a wind erosion problem in the Stevens Point area of central Wisconsin.

The scenario for the problem is:

- The farm is located near Stevens Point, WI in Portage County.
- The Cligen Station is Stevens Point and the Windgen Station is Wausau.
- The Soil Map Unit used in the evaluation is MfB-Mecan-100-LS.
- The original two year Cropping system is Spring Peas and Snap Beans (green).
- The field size is 2640’ X2640’, 160 acres.
- The WEPS evaluation of the cropping system will be run for 20 rotation cycles.

Below (Fig. 3.18) is the two year rotation of Spring Peas and Snap Beans (green) including the dates and field operations. Following evaluation of the erosion rates on the two year rotation, it has been decided to set up a three year rotation to include early potatoes.

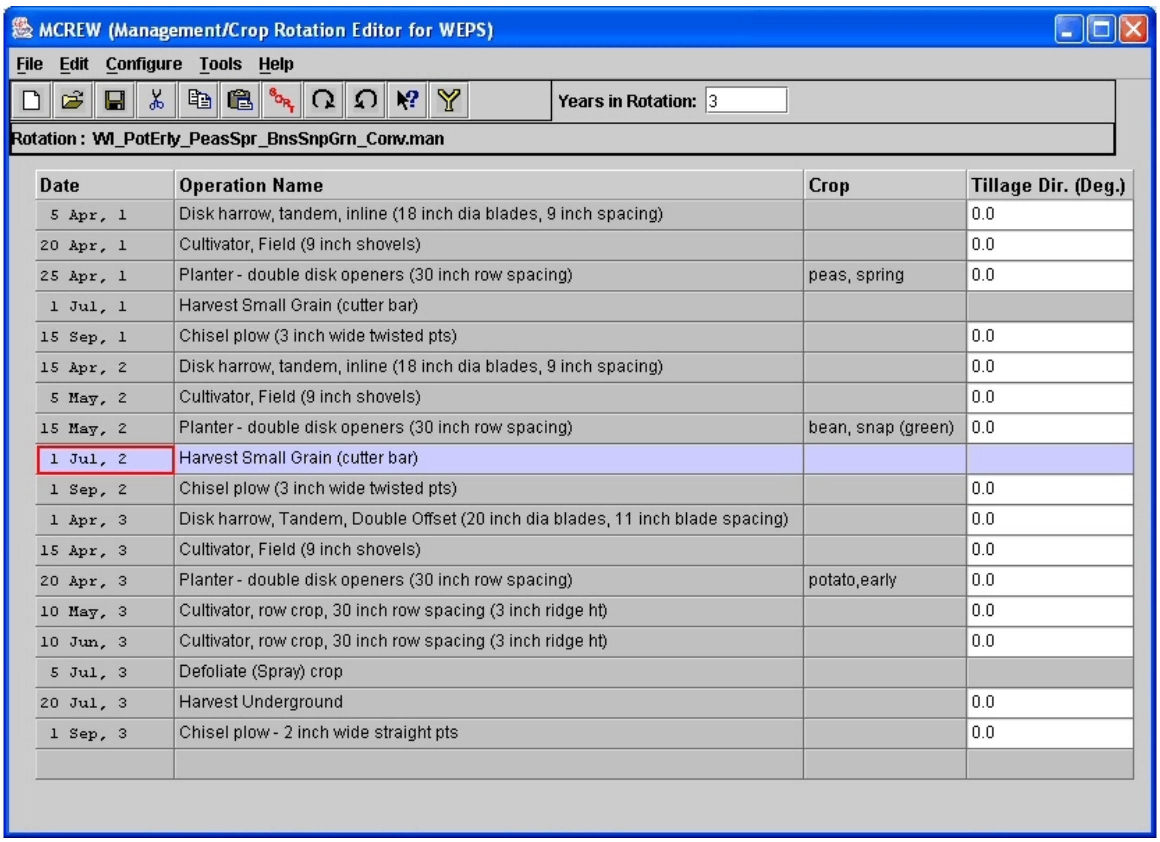


Date	Operation Name	Crop	Tillage Dir. (Deg.)
5 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
20 Apr, 1	Cultivator, Field (9 inch shovels)		0.0
25 Apr, 1	Planter - double disk openers (30 inch row spacing)	peas, spring	0.0
1 Jul, 1	Harvest Small Grain (cutter bar)		
15 Sep, 1	Chisel plow (3 inch wide twisted pts)		0.0
15 Apr, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
5 May, 2	Cultivator, Field (9 inch shovels)		0.0
15 May, 2	Planter - double disk openers (30 inch row spacing)	bean, snap (green)	0.0
1 Jul, 2	Harvest Small Grain (cutter bar)		
1 Sep, 2	Chisel plow (3 inch wide twisted pts)		0.0

Figure 3.18. A two year rotation of spring peas and snap beans (green).

When we expand the two year rotation to include Early Potatoes, we can add the operations, dates of operation, and the potato crop directly to the two year rotation or we can build a separate template for Early Potatoes and then insert the new template in the rotation. We recommend the option of building a separate template for Early Potatoes and then inserting it into the existing rotation. The new single year template for Early Potatoes begins when in MCREW by clicking on “File”, then click on “New” and this will drop a clean MCREW screen down. With the clean MCREW screen we enter dates and operations as instructed in the section on MCREW. The single year cropping scenario for early Potatoes should be saved as a template. We will save it by clicking on “file” and then “save as a template”. The list of management files will drop down and we will go to the window on the bottom of the list called “File name”, remove the * and then type in the name single crop scenario we are saving. To finalize we click “Save” on the bottom right of the window. We now have a new single year template and will add it to our two year rotation.

Below (Fig. 3.19) is the three year rotation of Early Potatoes, Spring Peas, and Snap Beans (green) including the dates and field operations. Following evaluation of the erosion rates on the three year rotation, it has been decided to set up a four year rotation to include Sweet Corn.

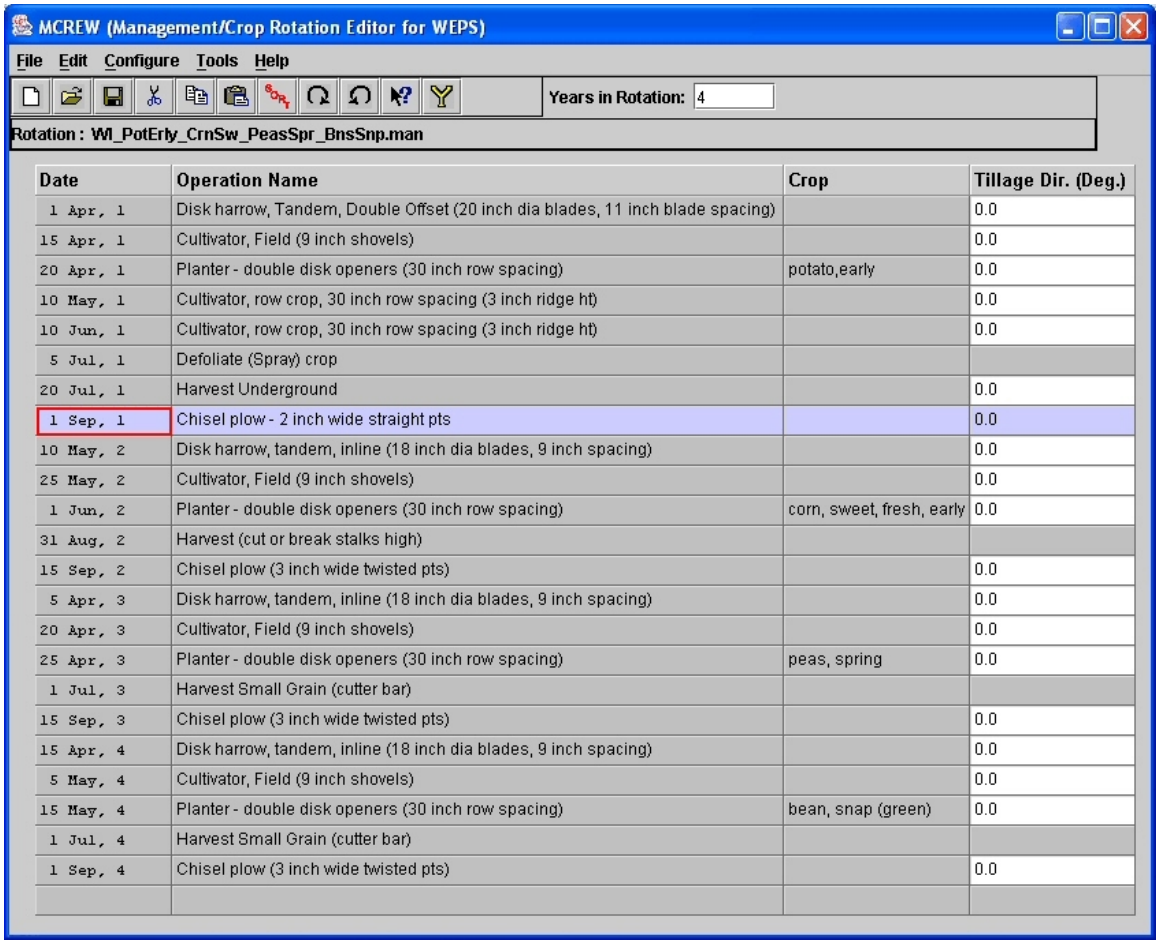


Date	Operation Name	Crop	Tillage Dir. (Deg.)
5 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
20 Apr, 1	Cultivator, Field (9 inch shovels)		0.0
25 Apr, 1	Planter - double disk openers (30 inch row spacing)	peas, spring	0.0
1 Jul, 1	Harvest Small Grain (cutter bar)		
15 Sep, 1	Chisel plow (3 inch wide twisted pts)		0.0
15 Apr, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
5 May, 2	Cultivator, Field (9 inch shovels)		0.0
15 May, 2	Planter - double disk openers (30 inch row spacing)	bean, snap (green)	0.0
1 Jul, 2	Harvest Small Grain (cutter bar)		
1 Sep, 2	Chisel plow (3 inch wide twisted pts)		0.0
1 Apr, 3	Disk harrow, Tandem, Double Offset (20 inch dia blades, 11 inch blade spacing)		0.0
15 Apr, 3	Cultivator, Field (9 inch shovels)		0.0
20 Apr, 3	Planter - double disk openers (30 inch row spacing)	potato,early	0.0
10 May, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
5 Jul, 3	Defoliate (Spray) crop		
20 Jul, 3	Harvest Underground		0.0
1 Sep, 3	Chisel plow - 2 inch wide straight pts		0.0

Figure 3.19. A three year rotation of early potatoes, spring peas, and snap beans (green).

When we expand the three year rotation to include Sweet Corn, we again, can add the operations, dates of operation, and the Sweet Corn crop directly to the three year rotation or we can build a separate template for Sweet Corn and insert the new template into the rotation. We again recommend the option of building a separate template for Sweet Corn and insert it into the existing rotation. Follow the same instruction used above for Early Potatoes to add Sweet Corn.

Below (Fig. 3.20) is the four year rotation of Early Potatoes, Sweet Corn, Spring Peas, and Snap Beans (green) including the dates and field operations. Following evaluation of the erosion rates on the four year rotation, it has been found acceptable.



MCREW (Management/Crop Rotation Editor for WEPS)

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Years in Rotation: 4

Rotation : WI_PotErly_CrnSw_PeasSpr_BnsSnp.man

Date	Operation Name	Crop	Tillage Dir. (Deg.)
1 Apr, 1	Disk harrow, Tandem, Double Offset (20 inch dia blades, 11 inch blade spacing)		0.0
15 Apr, 1	Cultivator, Field (9 inch shovels)		0.0
20 Apr, 1	Planter - double disk openers (30 inch row spacing)	potato,early	0.0
10 May, 1	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
5 Jul, 1	Defoliate (Spray) crop		
20 Jul, 1	Harvest Underground		0.0
1 Sep, 1	Chisel plow - 2 inch wide straight pts		0.0
10 May, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 May, 2	Cultivator, Field (9 inch shovels)		0.0
1 Jun, 2	Planter - double disk openers (30 inch row spacing)	corn, sweet, fresh, early	0.0
31 Aug, 2	Harvest (cut or break stalks high)		
15 Sep, 2	Chisel plow (3 inch wide twisted pts)		0.0
5 Apr, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
20 Apr, 3	Cultivator, Field (9 inch shovels)		0.0
25 Apr, 3	Planter - double disk openers (30 inch row spacing)	peas, spring	0.0
1 Jul, 3	Harvest Small Grain (cutter bar)		
15 Sep, 3	Chisel plow (3 inch wide twisted pts)		0.0
15 Apr, 4	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
5 May, 4	Cultivator, Field (9 inch shovels)		0.0
15 May, 4	Planter - double disk openers (30 inch row spacing)	bean, snap (green)	0.0
1 Jul, 4	Harvest Small Grain (cutter bar)		
1 Sep, 4	Chisel plow (3 inch wide twisted pts)		0.0

Figure 3.20. A four year rotation of early potatoes, sweet corn, spring peas, and snap beans (green).

EVALUATING WIND EROSION PROBLEMS WITH WEPS

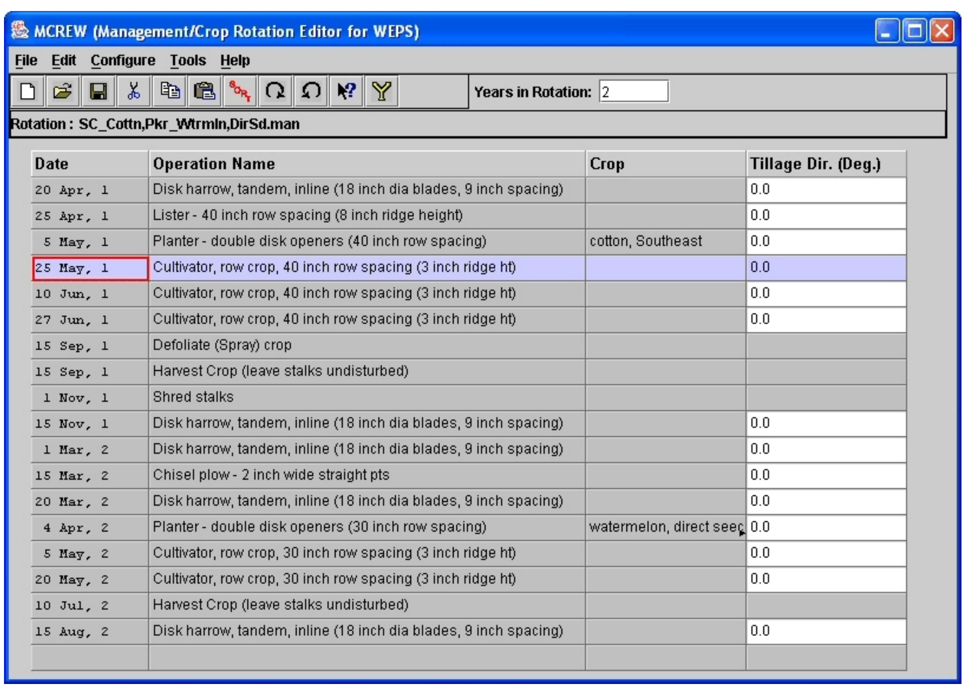
Following are some example problems that we will use to evaluate some wind erosion problems in Marlboro and Charleston Counties, South Carolina.

<u>Situation 1</u> -2 year rotation developing into a 4 year rotation

The scenario for the problem is:

- The farm is located in **Marlboro County, SC**
- The **Cligen station is McColl** and the **Windgen station is Eastover**
- The **Soil Map Unit** used in the evaluation is**: NoA - Norfolk LS**
- The original 2 year cropping system is **Cotton and Watermelons**
- The field size is: **x axis - 3500 ft.; y axis - 2000 ft.**
- Orientation of field operations and rows is **-45 degrees**
- Operations are performed parallel to x axis
- The early WEPS evaluations will be run for **5 rotation cycles**
- **Barriers** - Woods along the NW and NE field borders (trees w/leaves 4 rows)

Below is a 2 year rotation of **upland cotton** and **watermelons**, including the dates and field operations (Fig. 3.21).



Date	Operation Name	Crop	Tillage Dir. (Deg.)
20 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 Apr, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
5 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, Southeast	0.0
25 May, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
27 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 1	Defoliate (Spray) crop		
15 Sep, 1	Harvest Crop (leave stalks undisturbed)		
1 Nov, 1	Shred stalks		
15 Nov, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 2	Chisel plow - 2 inch wide straight pts		0.0
20 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
4 Apr, 2	Planter - double disk openers (30 inch row spacing)	watermelon, direct seec	0.0
5 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
20 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jul, 2	Harvest Crop (leave stalks undisturbed)		
15 Aug, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0

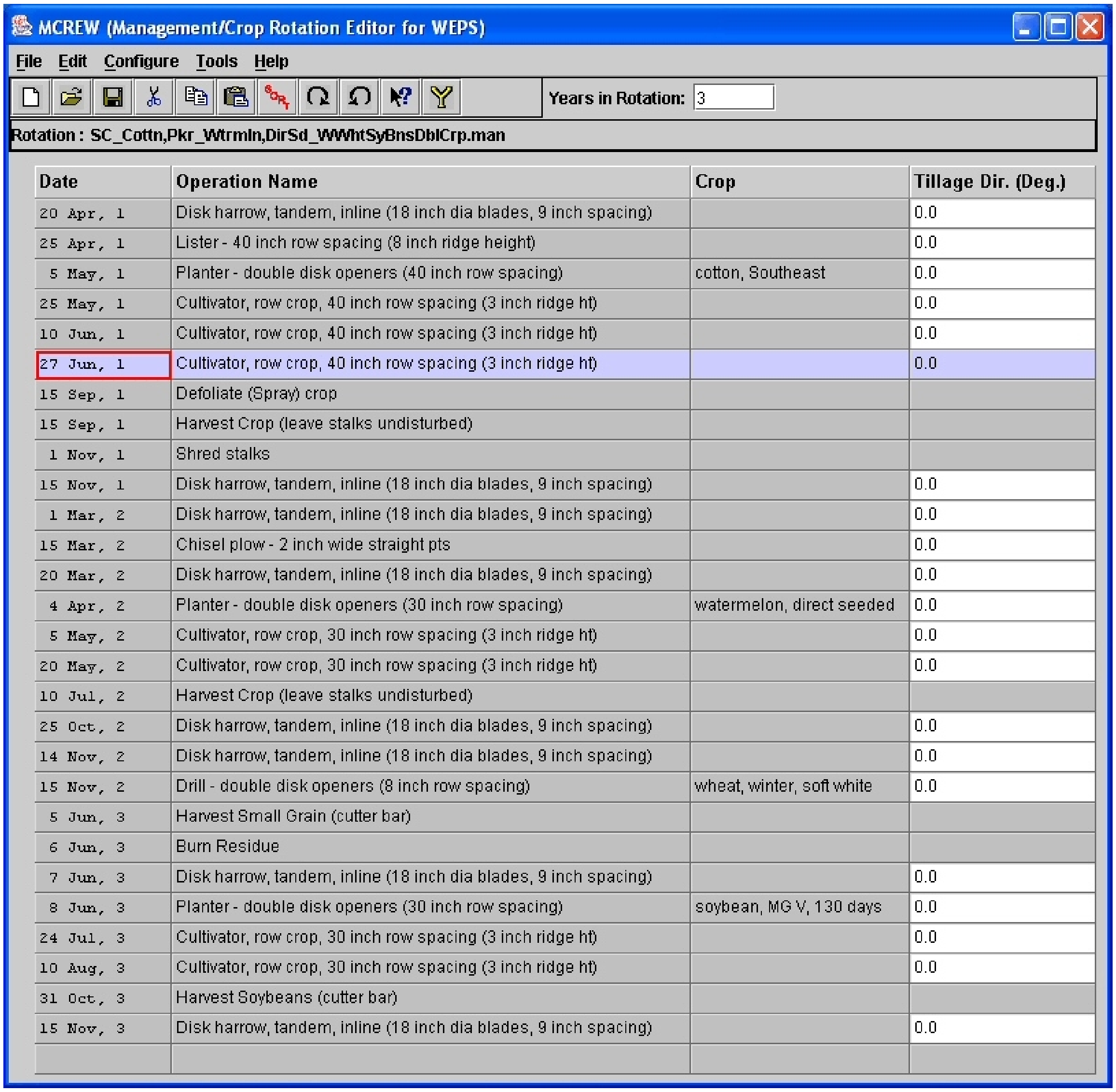
Figure 3.21. A two year rotation of upland cotton and watermelons.

***Cotton, Southeast** (700 lbs. lint yield)
04/20/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/25/01 Lister - 40 inch row spacing (8 inch ridge height)
05/05/01 Planter double disk openers (40 inch row spacing) – **Cotton, Southeast**
05/25/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/10/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/27/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
09/15/01 Defoliate (Spray) crop
09/15/01 Harvest crop (leave stalks undisturbed)
11/01/01 Shred stalks

*** Watermelons, direct seeded**
11/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/01/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/15/02 Chisel plow - 2 inch wide straight pts.
03/20/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/04/02 Planter - double disk openers (30 inch row spacing) - **Watermelon, direct seeded**
05/05/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
05/20/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
07/10/02 Harvest crop (leave stalks undisturbed)
08/15/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

When we expand the 2 year rotation to include winter wheat /soybeans (double cropped), we can add the operations, dates of operation, and the crops winter wheat /soybeans directly to the 2 year rotation or we can build a separate template for winter wheat /soybeans (double cropped). The new template can then be inserted into the rotation. We recommend the option of building the separate template for winter wheat /soybeans (double cropped) and the template will then be available the next time you are building a rotation that includes that crop.

Below is the 3 year rotation of Cotton, picker; Watermelons; and winter wheat /soybeans (double cropped), including the field operations and the dates they were performed (Fig. 3.22).



Date	Operation Name	Crop	Tillage Dir. (Deg.)
20 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 Apr, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
5 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, Southeast	0.0
25 May, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
27 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 1	Defoliate (Spray) crop		
15 Sep, 1	Harvest Crop (leave stalks undisturbed)		
1 Nov, 1	Shred stalks		
15 Nov, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 2	Chisel plow - 2 inch wide straight pts		0.0
20 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
4 Apr, 2	Planter - double disk openers (30 inch row spacing)	watermelon, direct seeded	0.0
5 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
20 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jul, 2	Harvest Crop (leave stalks undisturbed)		
25 Oct, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
14 Nov, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Nov, 2	Drill - double disk openers (8 inch row spacing)	wheat, winter, soft white	0.0
5 Jun, 3	Harvest Small Grain (cutter bar)		
6 Jun, 3	Burn Residue		
7 Jun, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
8 Jun, 3	Planter - double disk openers (30 inch row spacing)	soybean, MG V, 130 days	0.0
24 Jul, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Aug, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
31 Oct, 3	Harvest Soybeans (cutter bar)		
15 Nov, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0

Figure 3.22. A three year rotation of picker cotton, watermelons, and 130 day corn.

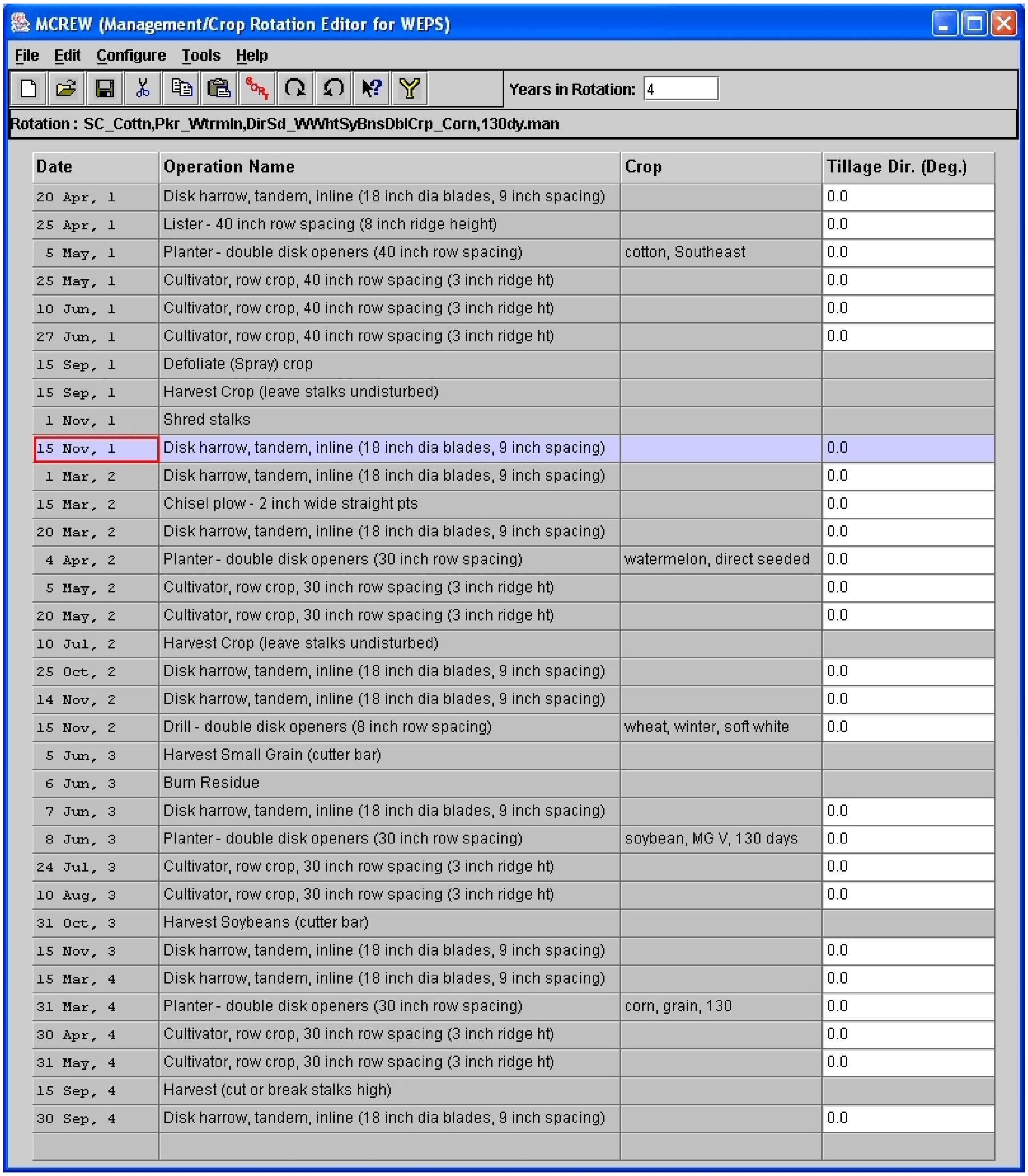
***Cotton, Southeast** (700 lbs. lint yield)
04/20/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/25/01 Lister - 40 inch row spacing (8 inch ridge height)
05/05/01 Planter double disk openers (40 inch row spacing) – **Cotton, Southeast**
05/25/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/10/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/27/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
09/15/01 Defoliate (Spray) crop
09/15/01 Harvest crop (leave stalks undisturbed)
11/01/01 Shred stalks

*** Watermelons, direct seeded**
11/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/01/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/15/02 Chisel plow - 2 inch wide straight pts.
03/20/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/04/02 Planter - double disk openers (30 inch row spacing) - **Watermelon, direct seeded**
05/05/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
05/20/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
07/10/02 Harvest crop (leave stalks undisturbed)

***Wheat, winter, soft white**
10/25/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
11/14/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
11/15/02 Drill - double disk openers (8 inch row spacing) – **wheat, winter, soft white**
06/05/03 Harvest Small Grain (cutter bar)
06/06/03 Burn residue (approximately 800 lbs of residue/acre left on surface)

***Soybeans**
06/07/03 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
06/08/03 Plant, double disk openers (30 inch row spacing) - **soybean, MG V, 130 days**
07/24/03 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
08/10/03 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
10/31/03 Harvest Soybeans (cutter bar)
11/20/03 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

Below is the 4 year rotation of picker cotton, watermelons, wheat-soybeans (double cropped); and corn, 130 day; including the field operations and the dates they were performed (Fig. 3.23).


MCREW (Management/Crop Rotation Editor for WEPS)

File Edit Configure Tools Help

Years in Rotation: 4

Rotation : SC_Cottn,Pkr_Wtrmln,DirSd_WWhtSyBnsDblCrp_Corn,130dy.man

Date	Operation Name	Crop	Tillage Dir. (Deg.)
20 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 Apr, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
5 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, Southeast	0.0
25 May, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
27 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 1	Defoliate (Spray) crop		
15 Sep, 1	Harvest Crop (leave stalks undisturbed)		
1 Nov, 1	Shred stalks		
15 Nov, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 2	Chisel plow - 2 inch wide straight pts		0.0
20 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
4 Apr, 2	Planter - double disk openers (30 inch row spacing)	watermelon, direct seeded	0.0
5 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
20 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jul, 2	Harvest Crop (leave stalks undisturbed)		
25 Oct, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
14 Nov, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Nov, 2	Drill - double disk openers (8 inch row spacing)	wheat, winter, soft white	0.0
5 Jun, 3	Harvest Small Grain (cutter bar)		
6 Jun, 3	Burn Residue		
7 Jun, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
8 Jun, 3	Planter - double disk openers (30 inch row spacing)	soybean, MG V, 130 days	0.0
24 Jul, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Aug, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
31 Oct, 3	Harvest Soybeans (cutter bar)		
15 Nov, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 4	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
31 Mar, 4	Planter - double disk openers (30 inch row spacing)	corn, grain, 130	0.0
30 Apr, 4	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
31 May, 4	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 4	Harvest (cut or break stalks high)		
30 Sep, 4	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0

Figure 3.23. A four year rotation of picker cotton, watermelons, wheat-soybeans (double cropped), and corn, 130 day.

***Cotton, Southeast** (700 lbs. lint yield)
04/20/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/25/01 Lister - 40 inch row spacing (8 inch ridge height)
05/05/01 Planter double disk openers (40 inch row spacing) – **Cotton, Southeast**
05/25/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/10/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/27/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
09/15/01 Defoliate (Spray) crop
09/15/01 Harvest crop (leave stalks undisturbed)
11/01/01 Shred stalks

*** Watermelons, direct seeded**
11/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/01/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/15/02 Chisel plow - 2 inch wide straight pts.
03/20/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/04/02 Planter - double disk openers (30 inch row spacing) - **Watermelon, direct seeded**
05/05/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
05/20/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
07/10/02 Harvest crop (leave stalks undisturbed)

***Wheat, winter, soft white**
10/25/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
11/14/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
11/15/02 Drill - double disk openers (8 inch row spacing) – **wheat, winter, soft white**
06/05/03 Harvest Small Grain (cutter bar)
06/06/03 Burn residue (approximately 800 lbs of residue/acre left on surface)

***Soybeans**
06/07/03 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
06/08/03 Plant, double disk openers (30 inch row spacing) - **soybean, MG V, 130 days**
07/24/03 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
08/10/03 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
10/31/03 Harvest Soybeans (cutter bar)
11/20/03 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

***Corn, 130 day**
03/15/04 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/01/04 Plant, double disk openers (30 inch row spacing) - **corn, grain, 130**
05/01/04 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)

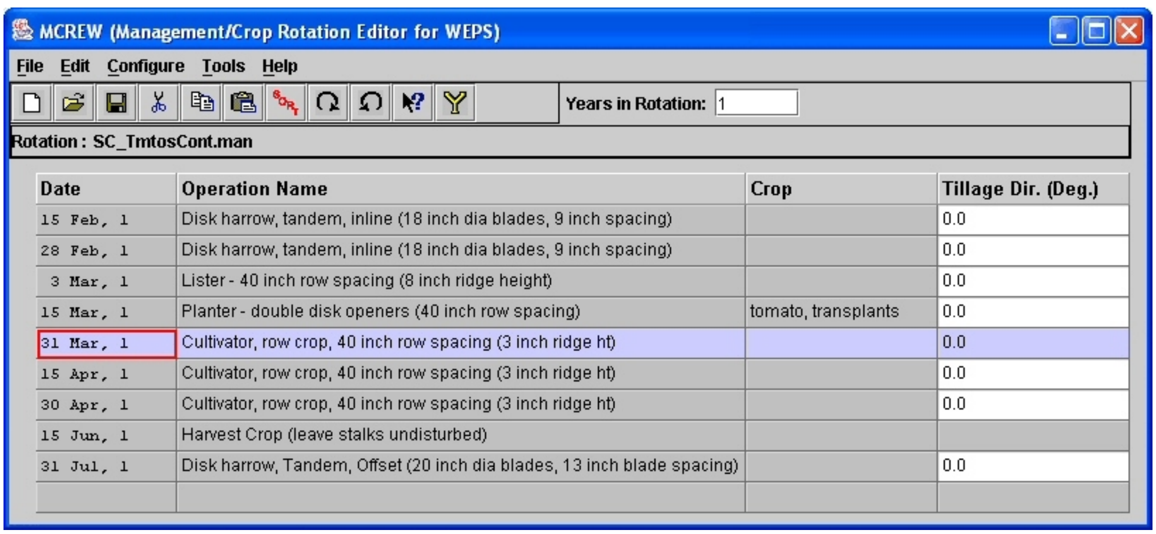
05/21/04 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
09/15/04 Harvest (cut or break stalks high)
10/15/04 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

Situation 2 - **Continuous Tomatoes**

This is another example problem that we will use to evaluate a wind erosion problem in Charleston County, SC.

The scenario for the problem is:
- The farm is located in **Charleston County, SC**
- The **Cligen station is Charleston** and the **Windgen station is Charleston**
- The **Soil Map Unit** used in the evaluation is: **NoA - Norfolk LS**
- The continuous cropping system is **Tomatoes**
- The **field size** is: x axis - 2000 ft.; y axis - 1500 ft.
- Orientation of field operations and rows is **-45 degrees**
- Operations are performed parallel to x axis
- The early WEPS evaluations will be run for **5 rotation cycles**
- **Barriers** - Woods along the NW and NE field borders (trees w/leaves 4 rows)

Below is the 1 year rotation of Tomatoes, including the dates and field operations (Fig. 3.24).



Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 Feb, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
28 Feb, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
3 Mar, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
15 Mar, 1	Planter - double disk openers (40 inch row spacing)	tomato, transplants	0.0
31 Mar, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Apr, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
30 Apr, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Jun, 1	Harvest Crop (leave stalks undisturbed)		
31 Jul, 1	Disk harrow, Tandem, Offset (20 inch dia blades, 13 inch blade spacing)		0.0

Figure 3.24. A one year rotation of tomatoes.

***Tomatoes**
02/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/01/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/03/01 Lister - 48 inch row spacing (8 inch ridge height)
03/12/01 transplant - **tomato, transplants**
04/01/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)

04/15/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
05/01/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/15/01 Harvest crop (leave stalks undisturbed)
07/25/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

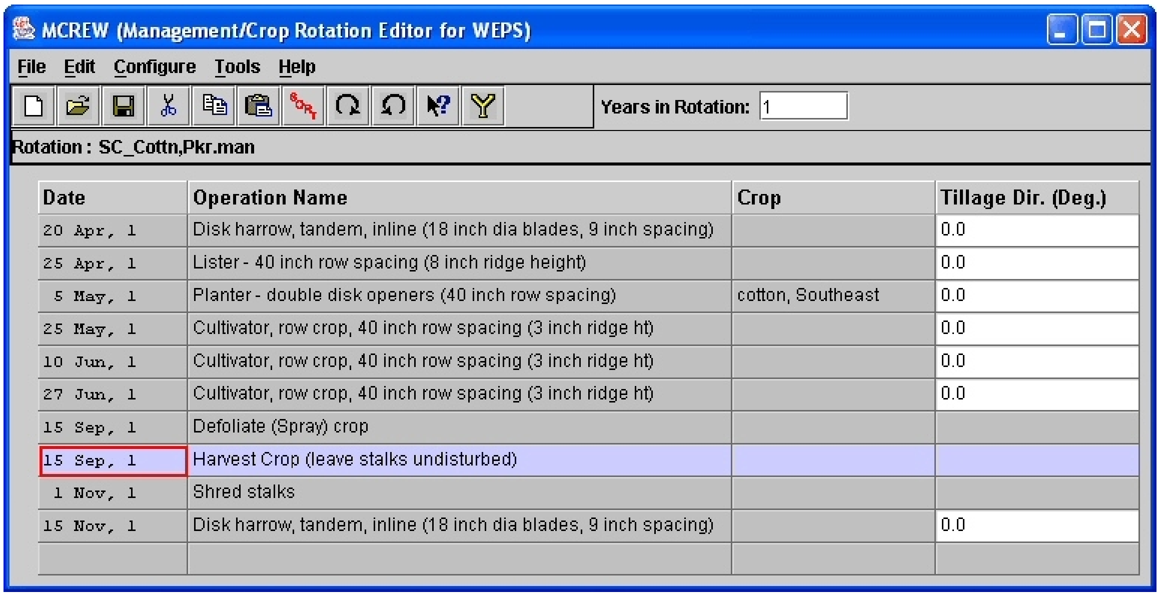
Situation 3 - Continuous Cotton

This is an example problem that we will use to evaluate a wind erosion problem in Marlboro County, SC.

The scenario for the problem is:

- The farm is located in **Marlboro County, SC**
- The **Cligen station is McColl** and the **Windgen station is Florence**
- The **Soil Map Unit** used in the evaluation is: **FaB - Faceville LS**
- The continuous cropping system is **Cotton, picker**
- The **field size** is: x axis - 3500 ft.; y axis - 2000 ft.
- Orientation of field operations and rows is **-45 degrees**
- Operations are performed parallel to x axis
- The early WEPS evaluations will be run for **5 rotation cycles**
- **Barriers** - Woods along the NW and NE field borders (trees w/leaves 4 rows)

Below is the 1 year rotation of **Cotton, Picker** including the dates and field operations (Fig. 3.25).


MCREW (Management/Crop Rotation Editor for WEPS)

File Edit Configure Tools Help

Years in Rotation: 1

Rotation : SC_Cottn,Pkr.man

Date	Operation Name	Crop	Tillage Dir. (Deg.)
20 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 Apr, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
5 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, Southeast	0.0
25 May, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
27 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 1	Defoliate (Spray) crop		
15 Sep, 1	Harvest Crop (leave stalks undisturbed)		
1 Nov, 1	Shred stalks		
15 Nov, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0

Figure 3.25. A one year rotation of picker cotton.

*__Cotton, Southeast__ (700 lbs. lint yield)
04/20/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/25/01 Lister - 40 inch row spacing (8 inch ridge height)
05/05/01 Planter double disk openers (40 inch row spacing) – **Cotton, Southeast**
05/25/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/10/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/27/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
09/15/01 Defoliate (Spray) crop
09/15/01 Harvest crop (leave stalks undisturbed)
11/01/01 Shred stalks
11/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

EVALUATING WIND EROSION PROBLEMS WITH WEPS

Following are some example problems that we will use to evaluate some wind erosion problems in Haakon County, South Dakota.

<u>Situation 1</u> -2 year rotation

The scenario for the problem is:

- The farm is located in **Haakon County, SD**
- The **Cligen station is Milesville** and the **Windgen station is Philip**
- The **Soil Map Unit** used in the evaluation is**: Craft Cv 85 VFSL**
- The original 2 year cropping system is **Winter Wheat-Fallow**
- The field size is: **x axis - 2600 ft.; y axis - 2600 ft.**
- Orientation of field operations and rows is – **North (0 or 360 degrees)**
- Operations are performed parallel to x axis
- The early WEPS evaluations will be run for **5 rotation cycles**
- Barriers - None

Below is the 2 year rotation of **Winter Wheat** and **Fallow**, including the dates and field operations (Fig. 3.26).

*__Winter Wheat__ (32 bu. yield) – **Fallow** (Conventional)

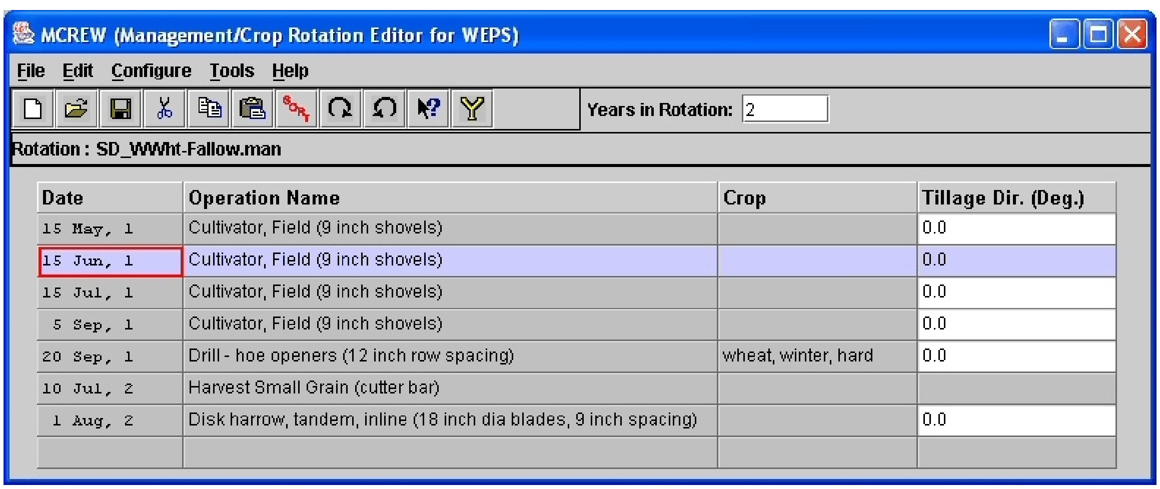
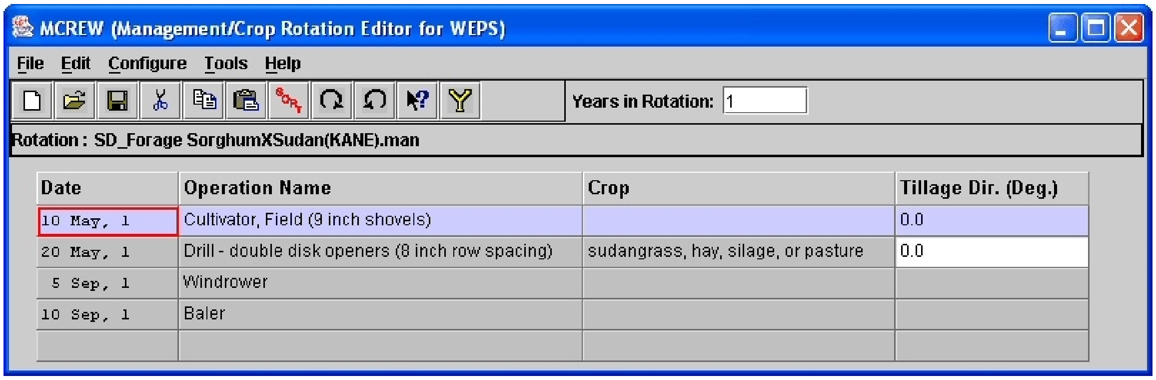


Figure 3.26. A two year rotation of winter wheat and fallow.

When we expand the 2 year rotation to include Forage Sorghum/Sudan Grass Cross (Kane) (Fig. 3.27), we can add the operations, dates of operation, and the Kane crop directly to the

2 year rotation or we can build a separate template for Kane. The new template can then be inserted into the rotation. We recommend the option of building the separate template for Kane and the template will then be available the next time you are building a rotation that includes that crop.

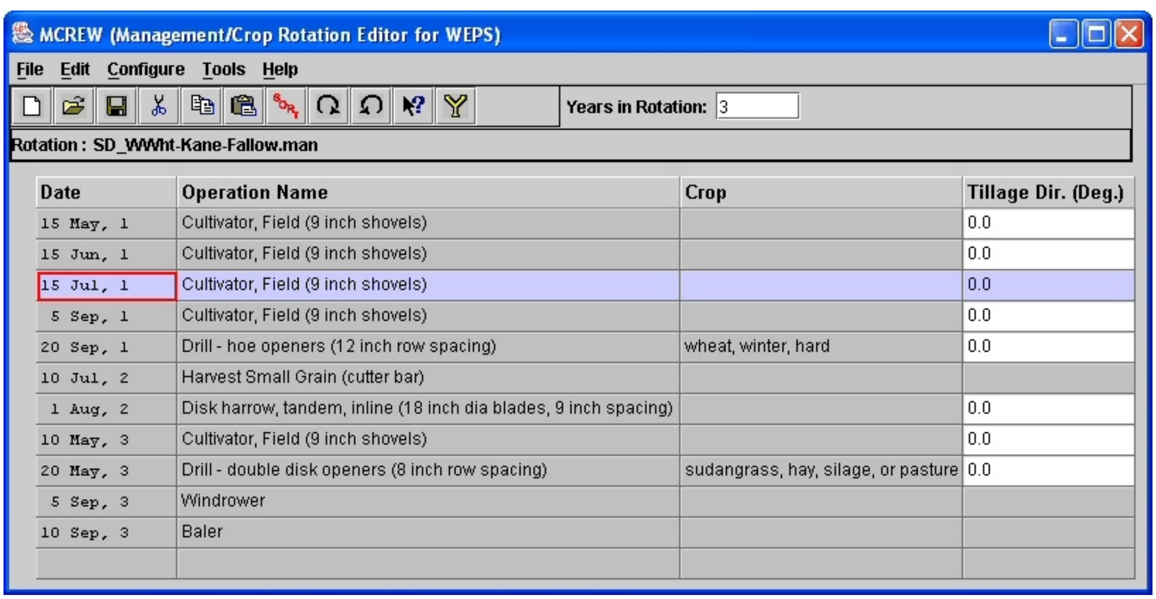


Date	Operation Name	Crop	Tillage Dir. (Deg.)
10 May, 1	Cultivator, Field (9 inch shovels)		0.0
20 May, 1	Drill - double disk openers (8 inch row spacing)	sudangrass, hay, silage, or pasture	0.0
5 Sep, 1	Windrower		
10 Sep, 1	Baler		

Figure 3.27. A one year rotation of forage sorghum/Sudan grass cross (kane).

Below is the 3 year rotation of Winter Wheat; Fallow; and Kane, including the field operations and the dates they were performed (Fig. 3.28).

***Winter Wheat** (32 bu. yield) – **Fallow** (Conventional) and **Kane** (~ 6000 lbs.)



Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 May, 1	Cultivator, Field (9 inch shovels)		0.0
15 Jun, 1	Cultivator, Field (9 inch shovels)		0.0
15 Jul, 1	Cultivator, Field (9 inch shovels)		0.0
5 Sep, 1	Cultivator, Field (9 inch shovels)		0.0
20 Sep, 1	Drill - hoe openers (12 inch row spacing)	wheat, winter, hard	0.0
10 Jul, 2	Harvest Small Grain (cutter bar)		
1 Aug, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
10 May, 3	Cultivator, Field (9 inch shovels)		0.0
20 May, 3	Drill - double disk openers (8 inch row spacing)	sudangrass, hay, silage, or pasture	0.0
5 Sep, 3	Windrower		
10 Sep, 3	Baler		

Figure 3.28. A three year rotation of winter wheat, fallow, and kane.

EVALUATING WIND EROSION PROBLEMS WITH WEPS

Following are some example management scenarios that we will use to evaluate a wind erosion problem in the Northwest area of Texas.

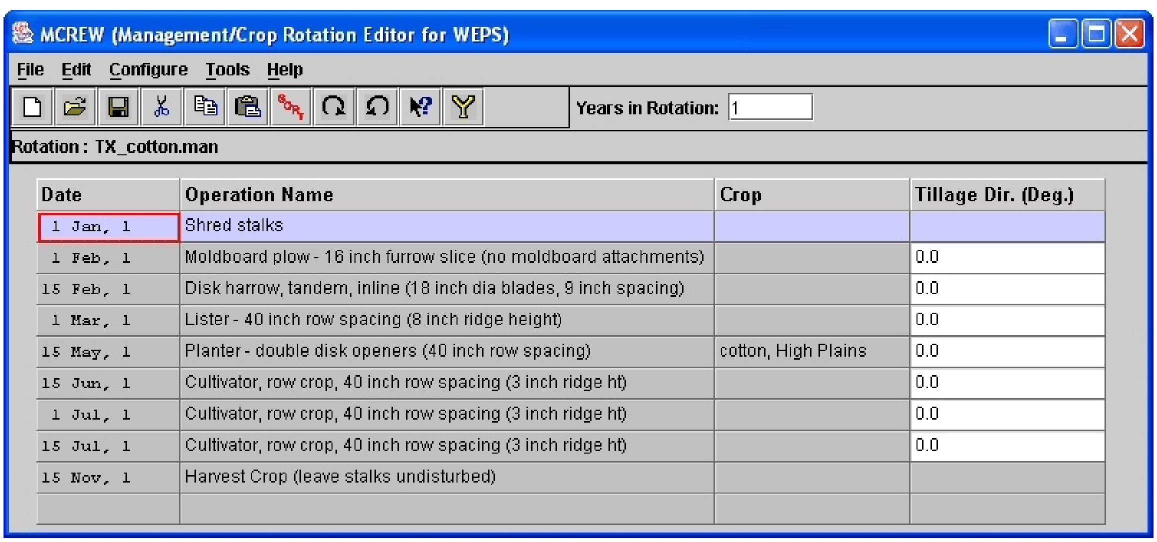
Situation 1 – Continuos Cotton rotation

The management scenario to be evaluated is:

- The **farm** is located in **Lubbock County, TX**.
- The **Cligen Station** is Lubbock and the **Windgen Station** is Lubbock
- The **Soil Map Unit** used in the evaluation is **Amarillo_4_100_LFS**
- The original Cropping system is **Continuos Cotton, stripper**
- The **field size** is 2640’ X 2640’ (160 acres)
- The WEPS evaluation of the cropping system will be run for **5 rotation cycles**

Below is the **Continuos Cotton** rotation including the **dates** and **field operations** (Fig. 3.29).

Cotton (Yield of ½ Bale)



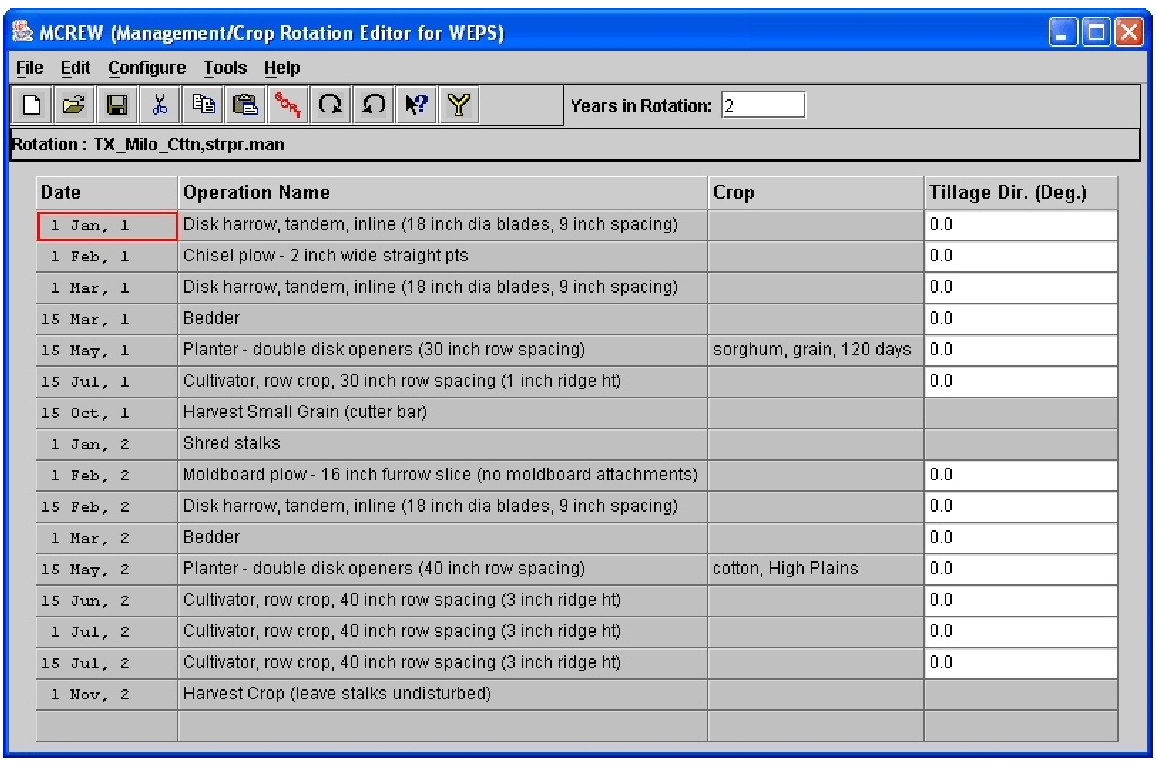
Date	Operation Name	Crop	Tillage Dir. (Deg.)
1 Jan, 1	Shred stalks		
1 Feb, 1	Moldboard plow - 16 inch furrow slice (no moldboard attachments)		0.0
15 Feb, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
15 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, High Plains	0.0
15 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
1 Jul, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Jul, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Nov, 1	Harvest Crop (leave stalks undisturbed)		

Figure 3.29. A continuos rotation of cotton.

<u>Situation 2</u> – Cotton_Milo rotation

When we expand the 1 year cotton rotation to include **Milo**, we can add the operations, dates of operations, and the **Milo** crop directly to the original **Cotton rotation** or we can build a separate template for **Milo** and then insert the new template in the rotation. We recommend the option of building a separate template for **Milo** and then inserting it into the existing **Cotton rotation**. The new **single year template** for **Milo** begins by opening **MCREW**, clicking on **"File**", then click on **"New"** and this will drop a clean **MCREW** screen down. With the clean **MCREW** screen we just start entering dates and operations as instructed in the earlier lessons on **MCREW**. The single year cropping scenario for **Milo** should be saved as a template. Saving a template begins by clicking on **"file"** and then **"save as a template"**. The list of dot man folders and files will drop down. Here we can open a folder before saving, or we can go directly to the window on the bottom of the list called **"File name",** remove the * and then type in the name of the new template we are saving. To finalize we click **"Save"** on the bottom right. We now have a new single year **Milo** template and will add it to our existing **Cotton scenario**.

Below is the **2 year rotation** of **Milo_Cotton**, including the dates and field operations (Fig. 3.30).

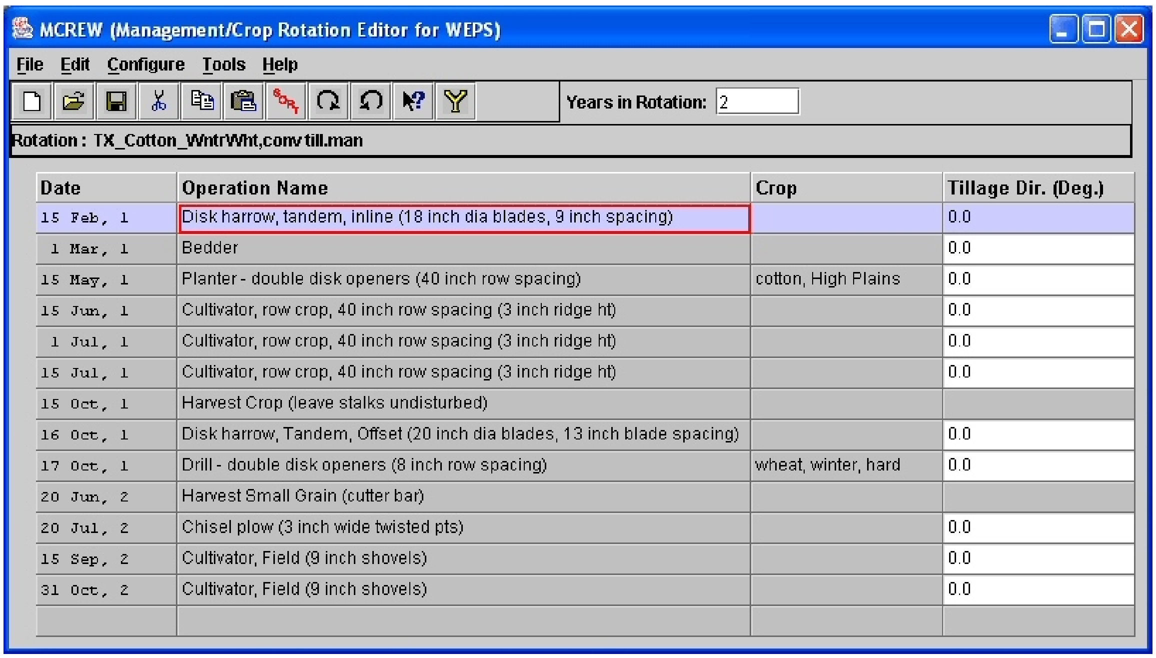


Date	Operation Name	Crop	Tillage Dir. (Deg.)
1 Jan, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Feb, 1	Chisel plow - 2 inch wide straight pts		0.0
1 Mar, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 1	Bedder		0.0
15 May, 1	Planter - double disk openers (30 inch row spacing)	sorghum, grain, 120 days	0.0
15 Jul, 1	Cultivator, row crop, 30 inch row spacing (1 inch ridge ht)		0.0
15 Oct, 1	Harvest Small Grain (cutter bar)		
1 Jan, 2	Shred stalks		
1 Feb, 2	Moldboard plow - 16 inch furrow slice (no moldboard attachments)		0.0
15 Feb, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 2	Bedder		0.0
15 May, 2	Planter - double disk openers (40 inch row spacing)	cotton, High Plains	0.0
15 Jun, 2	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
1 Jul, 2	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Jul, 2	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
1 Nov, 2	Harvest Crop (leave stalks undisturbed)		

Figure 3.30. A two year rotation of milo and cotton.

<u>Situation 3</u> – Cotton_Winter Wheat rotation

Below is the 2 year rotation of **Cotton_Winter Wheat** including the dates and field operations (Fig. 3.31). We recommend the option of building the rotation using separate templates of **Cotton** and **Winter Wheat**. However, once you have a template of **Cotton_Winter Wheat**, you can use it directly from your dot man files.



Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 Feb, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 1	Bedder		0.0
15 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, High Plains	0.0
15 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
1 Jul, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Jul, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Oct, 1	Harvest Crop (leave stalks undisturbed)		
16 Oct, 1	Disk harrow, Tandem, Offset (20 inch dia blades, 13 inch blade spacing)		0.0
17 Oct, 1	Drill - double disk openers (8 inch row spacing)	wheat, winter, hard	0.0
20 Jun, 2	Harvest Small Grain (cutter bar)		
20 Jul, 2	Chisel plow (3 inch wide twisted pts)		0.0
15 Sep, 2	Cultivator, Field (9 inch shovels)		0.0
31 Oct, 2	Cultivator, Field (9 inch shovels)		0.0

Figure 3.31. A two year rotation of cotton and winter wheat.

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APPENDICES

Interface

This section describes the WEPS 1.0 User Interface program implementation and how it interacts with the WEPS science model. The WEPS 'science' model refers to the computer code and executable program that performs the actual calculations of field conditions and erosion processes for a simulation run. A simple flow diagram of the WEPS science model and User Interface is shown in Figure 5.1. A detailed description of how to operate the WEPS 1.0 User Interface is described later in this document (Chapter, 'How to Operate WEPS').

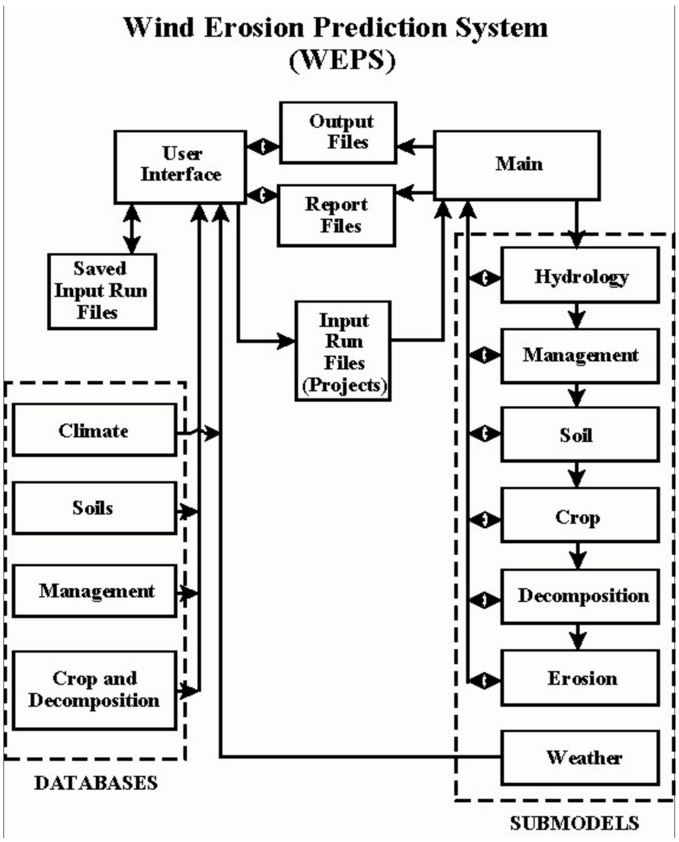

Figure 5.1. A flow diagram of the WEPS science model and User Interface.

A simplified description of the science model is provided later in this chapter. The inputs to the science model reside in a series of ASCII input files. These input files are: a Windgen file (*.win), a Cligen file (*.cli), an initial field conditions file (*.ifc), a management file (*.man), and a run file (weps.run). The science model can be executed from the command line through the interface. When WEPS is executed, the science model reads the input files accesses necessary databases, calls each submodel daily and performs the simulation, and writes output files. The output is written to one or more ASCII files. Although building the input files by hand, executing the model on the command line, and interpreting the output files can be time consuming and confusing, the WEPS 1.0 User Interface simplifies this process.

The WEPS 1.0 User Interface is written in Java. The interface can be thought of as a 'shell' or 'wrapper' around the science model which does not affect the execution of the science model. Through the interface program, the user can easily enter the information necessary to create and edit the input files. A description of how to enter this information is given later in this document (Chapter, 'How to Operate WEPS'). Once the field, location, soil, and management are described, pressing the 'Run' button performs a series of commands to execute the science model. The interface first calls the Cligen and Windgen weather generators which create the Windgen and Cligen files for the simulation. Then the WEPS science model is called and executed as described above. When the science model is finished, the interface reads and displays the output file.

Main Program

The MAIN program is the portion of the science model which controls the initialization and execution of a WEPS simulation run. It calls subroutines that read input data and outputs the general report. In addition, MAIN calls submodels on a daily basis, which update the field conditions. If the maximum wind speed for the day exceeds a set velocity great enough to cause soil movement (i.e., 8 m/s), MAIN then calls the EROSION submodel to simulate erosion processes. The current version of WEPS reads in the climate data produced by the WEATHER submodel; performs daily simulation of the hydrologic and soil conditions, crop growth, and residue decomposition; and accounts for management effects. Finally, the model determines soil erosion by wind for the desired simulation period.

Program Description

The current version of MAIN requires the following files for a WEPS simulation run: a) a simulation run file which describes the field shape and barriers, simulation period, location of other input files, and types of output ; b) an initial field conditions file which describes soil conditions at the start of a simulation; d) a tillage/management file which describes the management system; and e) two climate files, one each in the CLIGEN and WINDGEN formats, that provide climate data on a daily basis.

The MAIN program begins by initializing local variables and then calls the subroutine INPUT which reads the simulation run file and the initial field conditions file. The simulation then is executed as a daily loop that controls the counters for the current day and an embedded subregion loop. The model can perform any length of simulation on a daily time step. However, WEPS performs a simulation for one rotation cycle to initialize surface conditions before simulations of wind erosion are performed. For each simulation day, the daily weather is read from the CLIGEN and WINDGEN data files. As some of the submodels are executed, summary information may be compiled for output. All submodels except EROSION are called within the subregion loop. Once field conditions are updated, if maximum wind speed for the day exceeds a set minimum (i.e., 8 m/s), the EROSION submodel then is called to determine threshold conditions and compute soil erosion. Finally, the MAIN program calls subroutine BOOKEEPING to account for field conditions and soil loss for periods throughout the rotation. CALTOT is then called, which outputs a series of user-selected output forms with general information about the simulation run.

The “WEPS Technical Description” provides a more detailed description of the science behind WEPS and is available from WERU. The current WEPS science model is coded in FORTRAN conforming to the ANSI FORTRAN 77 and Fortran 95 standard. The inputs to the science model reside in a series of ASCII input files. These input files are: a Windgen file (*.win), a Cligen file (*.cli), an initial field conditions file (*.ifc), a management file (*.man), and a run file (weps.run). The science model can be executed from the command line or the interface. When WEPS is executed, the science model reads the input files accesses necessary databases, calls each submodel daily and performs the simulation, and writes output files. The output is written to one or more ASCII files.

Weather Submodel and Database

Introduction

WEPS requires wind speed and direction in order to simulate the process of soil erosion by wind. These and other weather variables (precipitation, air temperature, solar radiation) are also needed to drive temporal changes in hydrology, soil erodibility, crop growth, and residue decomposition in WEPS.

It is not practical to use measured historical wind data with WEPS, since many wind records have missing data. Also, one may want to simulate wind erosion for a longer period than the length of the measured data record, e.g. for 40 years, which is a typical WEPS simulation run. In addition, the measured data require much more computer disk space than wind summary statistics combined with a stochastic wind generator. Therefore, a stochastic wind generator is more appropriate for use with WEPS than using the measured data directly. WINDGEN is the program that simulates wind speed and direction for WEPS (van Donk et al., 2004). An earlier version of WINDGEN was described by Skidmore and Tatarko (1990). It was developed specifically for use with WEPS and stochastically generates daily wind direction and hourly wind speed.

CLIGEN is the weather generator developed for the Water Erosion Prediction Project (WEPP) family of erosion models (Nicks et al., 1987). It is used by WEPS to calculate an average annual air temperature as well as stochastically generate daily precipitation, maximum and minimum temperature, dew point temperature, and solar radiation. Average daily air temperature and elevation for the site are used to calculate average daily air density within WEPS. Those interested in CLIGEN and how it simulates these variables should consult the WEPP documentation (Nicks and Lane, 1989). Both CLIGEN and WINDGEN are executed under the WEPS 1.0 user interface.

Distributions of weather variables are needed by stochastic weather generators in order to be able to generate data. Wind speed distributions have been described by the two-parameter Weibull model (Takle and Brown, 1978; Corotis et al., 1978; Skidmore and Tatarko, 1990), the two-parameter gamma model (Nicks and Lane, 1989), and the one-parameter Rayleigh model, which is a special case of the Weibull (Hennessey, 1977; Corotis et al., 1978). The Weibull is the most widely used model.

A stochastic wind generator had been developed for use with WEPS (Skidmore and Tatarko, 1990). It generated wind speeds from Weibull parameters, but they were suspect in certain locations. Another reason for revisiting this subject was the availability of an updated, quality controlled, hourly wind database obtained from the National Climatic Data Center (NCDC).

Data set

A quality controlled hourly wind data set (TD-6421, version 1.1), including 1304 stations in the 48 contiguous states of the USA, was obtained from NCDC. It includes data up to the year 2000 (1976 for the previous WEPS data set), providing longer data records and more recent data. The longest record is 65 years. Stations with less than 5 years of data were excluded, leaving 971 stations for use with a stochastic generator. This provided a denser network than the 673 stations previously used in WEPS.

The data set contains both Automated Surface Observing System (ASOS; Lockhart, 2000; McKee et al., 2000) data and data collected before ASOS. The ASOS data are 2-minute averages and the before-ASOS data are 1-minute averages. ASOS coverage has only begun recently. More than 800 stations have no ASOS data at all and none of the stations has more than 8 years of ASOS data. Analysis of 28 stations with the longest ASOS records showed that on average for the ASOS data the mean wind speed was 3.6 m/s, the erosive wind power density was 2.9 Wm^{-2}, and the percentage of wind speeds exceeding 10 m/s was 1.8%. For the before-ASOS data, these figures were 4.0 m/s, 5.3 Wm^{-2}, and 2.8% respectively. Despite these differences we decided to use all data in order to have the benefit of the full data record, rather than reducing the record length by excluding either the ASOS data or the before-ASOS data.

Stochastic wind generator

There are two steps in the stochastic generation of wind data from measured data. First, statistics need to be created from the measured data, describing the distributions of wind direction and speed. Second, the wind data are generated from the statistics. Wind speeds are generated by month and by wind direction, since some months and directions are likely to be windier than others. Wind speed by month is important because a field may be protected against wind erosion in one month, but not in another. Wind speed by direction is important for determining distances to non-erodible field boundaries. Wind direction relative to the direction of tillage operations and row crops is also important for wind erosion. In addition, the proper placement of wind barrie 5 rs depends on wind direction.

Creation of statistics to be used for stochastic wind generation

Wind direction frequencies are calculated for each of 16 directions plus calm for each month (Table 5.1). Wind speeds that are not calm are sorted into 25 classes (Table 5.2) for each month-direction combination (12*16 = 192 combinations per station). Rather than using the Weibull model, we chose to use the measured distribution itself, without fitting to any model, but instead using linear interpolation between the measured distribution points (Figures 5.2 and 5.3). The reasons for this choice are described by van Donk et al. (2004). Thus, for the generation of wind speeds, the entire distribution needs to be available for each month-direction combination (Table 5.3).

Table 5.1. Wind direction frequencies (%) for Sidney, Nebraska for 12 months and 16 cardinal wind directions plus calm. If a wind speed is less than or equal to 0.5 m/s, it is assigned to calm, else it is assigned to one of the 16 cardinal directions. Each month (column) adds up to 100 percent.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NORTH	6.0	7.5	10.1	10.8	9.9	8.4	7.3	7.2	8.9	8.3	7.5	6.6
NNE	2.0	2.7	3.6	4.2	4.3	4.0	4.2	4.0	4.3	3.3	2.8	2.5
NE	1.6	2.0	2.4	3.3	3.8	3.5	3.9	3.9	3.3	2.4	1.6	1.5
ENE	1.5	1.8	2.4	2.9	3.2	3.7	3.8	3.3	2.9	1.8	1.3	1.2
EAST	1.9	2.3	3.3	4.0	4.4	6.0	5.7	4.4	3.8	3.0	1.6	1.5
ESE	1.5	2.0	3.7	3.9	4.6	5.4	5.3	4.7	3.4	2.7	1.4	1.0
SE	2.4	3.0	4.7	5.4	6.6	7.4	8.8	7.7	5.4	4.1	2.2	1.5
SSE	3.9	4.7	6.3	7.2	10.4	10.1	11.5	11.8	9.4	6.3	3.3	2.7
SOUTH	5.7	6.4	7.9	7.7	11.9	13.4	13.9	14.7	13.1	8.4	6.1	5.4
SSW	4.4	4.7	4.2	4.3	4.7	5.3	6.1	6.6	6.3	5.0	5.7	5.2
SW	6.6	5.5	4.8	3.9	3.7	4.4	4.4	4.8	5.1	5.4	6.3	7.1
WSW	6.6	5.2	4.1	3.3	2.9	3.5	3.4	3.4	3.8	4.8	6.3	7.2
WEST	17.5	15.1	10.6	8.0	5.7	6.0	5.6	6.5	8.0	12.9	16.7	17.3
WNW	17.4	14.7	11.1	10.3	6.9	5.9	5.0	6.0	8.2	12.0	14.9	17.8
NW	11.2	11.4	9.6	9.7	7.2	5.8	4.6	5.0	7.0	10.0	11.5	12.2
NNW	8.5	9.4	9.5	9.6	7.6	5.6	4.6	4.2	5.8	8.1	8.9	8.1
CALM	1.4	1.7	1.5	1.4	2.1	1.6	2.0	1.6	1.6	1.4	1.9	1.2

Table 5.2. Wind speeds other than calm are sorted into 25 classes. The upper wind speed limit is inclusive, e.g. a wind speed of 2.5 m/s goes into the class #2. For the last class, the central wind speed was chosen as 43 m/s, as if the upper limit were 45.5 m/s. In reality the upper limit of the last class is infinity.

	Wind speeds (m/s)		
Class #	Lower	Upper	Central
1	0.5	1.5	1.0
2	1.5	2.5	2.0
3	2.5	3.5	3.0
.	.	.	.
.	.	.	.
17	16.5	17.5	17.0
18	17.5	18.5	18.0
19	18.5	19.5	19.0
20	19.5	20.5	20.0
21	20.5	25.5	23.0
22	25.5	30.5	28.0
23	30.5	35.5	33.0
24	35.5	40.5	38.0
25	40.5	inf.	43.0

Table 5.3. Cumulative wind speed distributions for Sidney, Nebraska for 12 months and 16 cardinal wind directions. The highlighted distribution is shown in Figures 5.2 and 5.3.

	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	… m/s
JAN NORTH	0.074	0.188	0.256	0.404	0.539	0.672	0.771	0.868	0.924	0.951	0.965	…
JAN NNE	0.075	0.259	0.375	0.544	0.675	0.784	0.866	0.944	0.975	0.991	0.994	…
JAN NE	0.117	0.340	0.449	0.619	0.769	0.883	0.915	0.943	0.964	0.988	0.988	…
JAN ENE	0.141	0.389	0.509	0.735	0.885	0.979	0.996	0.996				
JAN EAST	0.161	0.339	0.426	0.613	0.781	0.906	0.942	0.977	0.990	0.997		
JAN ESE	0.139	0.325	0.398	0.597	0.736	0.844	0.900	0.961	0.970	0.991	0.996	…
JAN SE	0.090	0.227	0.339	0.561	0.713	0.840	0.899	0.956	0.987	0.995	0.997	
JAN SSE	0.064	0.195	0.268	0.478	0.651	0.802	0.890	0.957	0.987	0.998		
JAN SOUTH	0.080	0.232	0.353	0.583	0.761	0.859	0.906	0.954	0.976	0.993	0.997	…
JAN SSW	0.057	0.197	0.306	0.543	0.735	0.860	0.915	0.969	0.980	0.994	0.996	…
JAN SW	0.079	0.238	0.333	0.576	0.761	0.870	0.923	0.973	0.990	0.999		
JAN WSW	0.058	0.240	0.359	0.657	0.822	0.906	0.951	0.978	0.988	0.997		
JAN WEST	0.035	0.135	0.214	0.437	0.673	0.825	0.896	0.942	0.961	0.978	0.982	…
JAN WNW	0.023	0.082	0.133	0.304	0.533	0.702	0.798	0.883	0.914	0.945	0.960	…
JAN NW	0.028	0.092	0.152	0.326	0.503	0.617	0.696	0.801	0.861	0.921	0.942	…
JAN NNW	0.033	0.097	0.146	0.269	0.392	0.523	0.623	0.729	0.807	0.865	0.906	…
FEB NORTH	0.068	0.189	0.262	0.415	0.586	0.710	0.788	0.887	0.931	0.967	0.980	…
FEB NNE	0.134	0.312	0.413	0.602	0.718	0.829	0.894	0.952	0.975	0.990	0.995	…
FEB NE	0.119	0.317	0.409	0.617	0.785	0.865	0.927	0.980	0.997	0.997	0.997	…
.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.
DEC WNW	0.022	0.092	0.156	0.331	0.550	0.708	0.793	0.864	0.909	0.941	0.959	…
DEC NW	0.034	0.101	0.151	0.324	0.491	0.613	0.699	0.794	0.857	0.908	0.934	…
DEC NNW	0.037	0.122	0.185	0.314	0.438	0.534	0.630	0.743	0.815	0.876	0.914	…

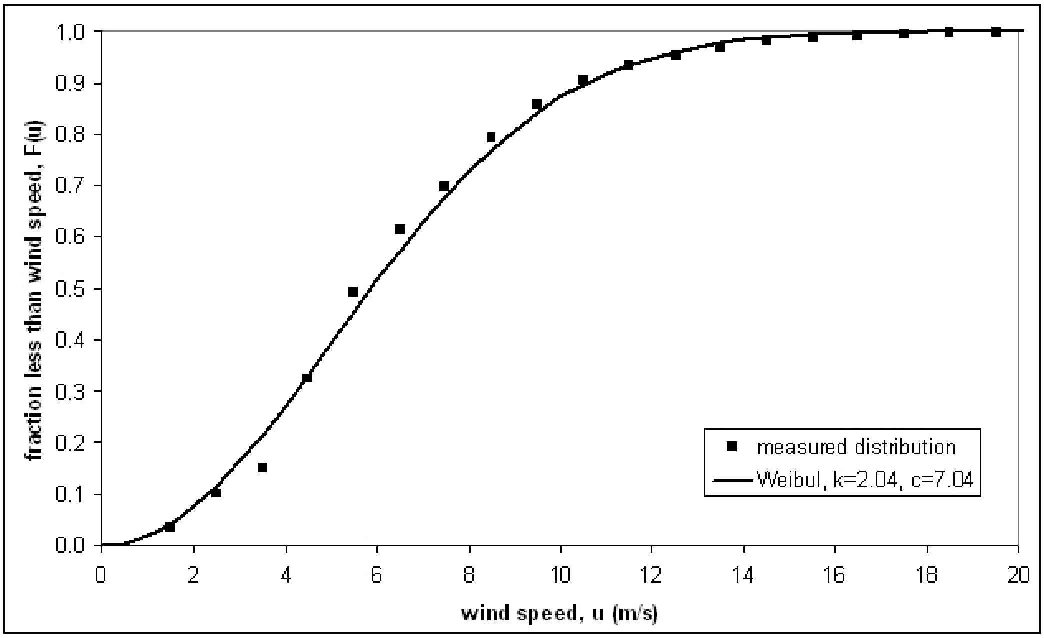

Figure 5.2. Cumulative distribution of measured wind speed and fitted Weibull curve for Sidney, Nebraska for December with winds coming from the Northwest.

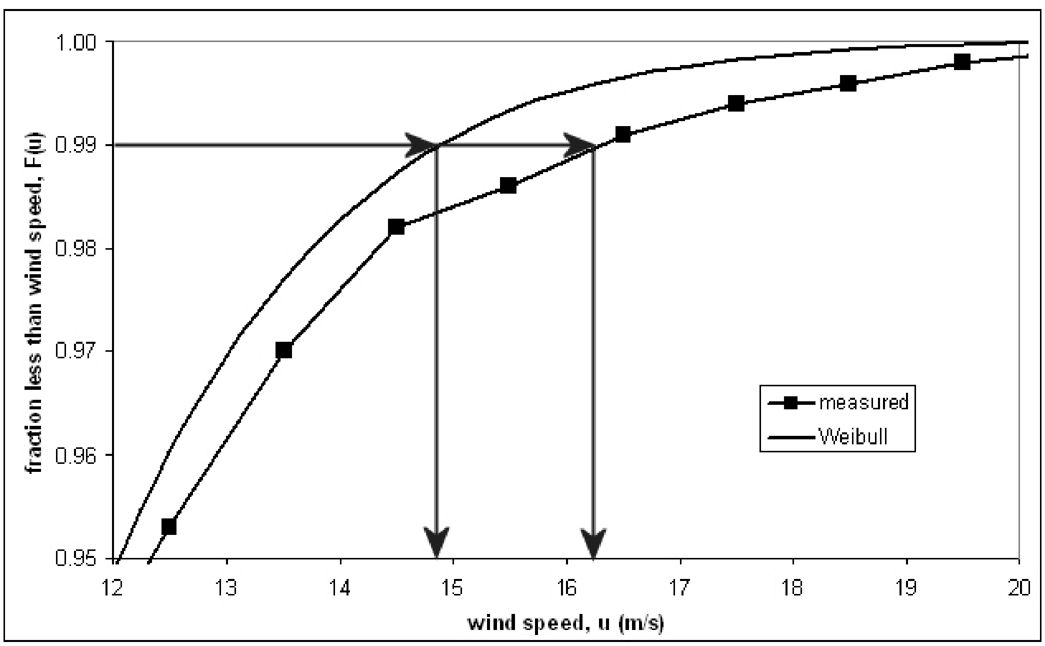

Figure 5.3. As Figure 5.2, but zoomed in at higher wind speeds. In this example, drawing a random number of 0.99, the Weibull curve generates a wind speed of ~14.8 m/s and the direct method would generate a wind speed of ~16.3 m/s.

Stochastic wind generation
Typically, for use with WEPS, wind data are generated for many, e.g. 40, years. First, one of the 16 cardinal wind directions or calm is selected from Table 5.1 using a random number generator with the distribution for the current month. The selected direction is applied for an entire day. Next, 24 hourly wind speeds are generated for this day. If calm was selected in the previous step, 24 wind speeds of 0 m/s are generated. Otherwise, if one of 16 directions was selected, 24 wind speeds are generated from the cumulative distribution. The distribution for the current month and direction (Table 5.3) is selected and a wind speed is generated from the linearly interpolated distribution, using a random number generator (Figure 5.3).

The average dust storm lasts 6.6 hours in the U.S. Great Plains (Hagen and Woodruff, 1973), but there is no auto-correlation for the generated hourly wind speeds in WEPS. Instead, as a first approximation, the hourly wind speeds are rearranged to create more realistic windstorms that last longer than one hour. Preliminary tests have shown that simulated wind erosion is not very sensitive to how the winds speeds are rearranged. Also, there is no cross-correlation with other weather elements in WEPS, although it does exist. Wind speed may be correlated with precipitation (S.M. Visser, personal communication) and with change in maximum air temperature from one day to the next (G.L. Johnson, personal communication). Auto- and cross-correlation may be incorporated in a future version of WEPS. Computer programs to convert measured wind data into the summary statistics described here (Table 5.4) and to generate winds from these statistics are available upon request.

Table 5.4. Example WINDGEN database record for Sidney, Nebraska. From this record, WINDGEN stochastically generates wind directions and speeds that are then used as input for WEPS.

```
1       # 725610 US NE SIDNEY
2       41 6 N 102 59 W 1312 19770101 20001231 AUU
3         6.0  7.5 10.1 10.8  9.9  8.4  7.3  7.2  8.9  8.3  7.5  6.6
4         2.0  2.7  3.6  4.2  4.3  4.0  4.2  4.0  4.3  3.3  2.8  2.5
5         1.6  2.0  2.4  3.3  3.8  3.5  3.9  3.9  3.3  2.4  1.6  1.5
6         1.5  1.8  2.4  2.9  3.2  3.7  3.8  3.3  2.9  1.8  1.3  1.2
7         1.9  2.3  3.3  4.0  4.4  6.0  5.7  4.4  3.8  3.0  1.6  1.5
8         1.5  2.0  3.7  3.9  4.6  5.4  5.3  4.7  3.4  2.7  1.4  1.0
9         2.4  3.0  4.7  5.4  6.6  7.4  8.8  7.7  5.4  4.1  2.2  1.5
10        3.9  4.7  6.3  7.2 10.4 10.1 11.5 11.8  9.4  6.3  3.3  2.7
11        5.7  6.4  7.9  7.7 11.9 13.4 13.9 14.7 13.1  8.4  6.1  5.4
12        4.4  4.7  4.2  4.3  4.7  5.3  6.1  6.6  6.3  5.0  5.7  5.2
13        6.6  5.5  4.8  3.9  3.7  4.4  4.4  4.8  5.1  5.4  6.3  7.1
14        6.6  5.2  4.1  3.3  2.9  3.5  3.4  3.4  3.8  4.8  6.3  7.2
15       17.5 15.1 10.6  8.0  5.7  6.0  5.6  6.5  8.0 12.9 16.7 17.3
16       17.4 14.7 11.1 10.3  6.9  5.9  5.0  6.0  8.2 12.0 14.9 17.8
17       11.2 11.4  9.6  9.7  7.2  5.8  4.6  5.0  7.0 10.0 11.5 12.2
18        8.5  9.4  9.5  9.6  7.6  5.6  4.6  4.2  5.8  8.1  8.9  8.1
19        1.4  1.7  1.5  1.4  2.1  1.6  2.0  1.6  1.6  1.4  1.9  1.2
20      0.074 0.188 0.256 0.404 0.539 0.672 0.771 0.868 0.924 0.951 0.965 …
21      0.075 0.259 0.375 0.544 0.675 0.784 0.866 0.944 0.975 0.991 0.994 …
22      0.117 0.340 0.449 0.619 0.769 0.883 0.915 0.943 0.964 0.988 0.988 …
23      0.141 0.389 0.509 0.735 0.885 0.979 0.996 0.996
24      0.161 0.339 0.426 0.613 0.781 0.906 0.942 0.977 0.990 0.997
25      0.139 0.325 0.398 0.597 0.736 0.844 0.900 0.961 0.970 0.991 0.996 …
26      0.090 0.227 0.339 0.561 0.713 0.840 0.899 0.956 0.987 0.995 0.997
27      0.064 0.195 0.268 0.478 0.651 0.802 0.890 0.957 0.987 0.998
28      0.080 0.232 0.353 0.583 0.761 0.859 0.906 0.954 0.976 0.993 0.997 …
29      0.057 0.197 0.306 0.543 0.735 0.860 0.915 0.969 0.980 0.994 0.996 …
30      0.079 0.238 0.333 0.576 0.761 0.870 0.923 0.973 0.990 0.999
31      0.058 0.240 0.359 0.657 0.822 0.906 0.951 0.978 0.988 0.997
32      0.035 0.135 0.214 0.437 0.673 0.825 0.896 0.942 0.961 0.978 0.982 …
33      0.023 0.082 0.133 0.304 0.533 0.702 0.798 0.883 0.914 0.945 0.960 …
34      0.028 0.092 0.152 0.326 0.503 0.617 0.696 0.801 0.861 0.921 0.942 …
35      0.033 0.097 0.146 0.269 0.392 0.523 0.623 0.729 0.807 0.865 0.906 …
36      0.068 0.189 0.262 0.415 0.586 0.710 0.788 0.887 0.931 0.967 0.980 …
37      0.134 0.312 0.413 0.602 0.718 0.829 0.894 0.952 0.975 0.990 0.995 …
38      0.119 0.317 0.409 0.617 0.785 0.865 0.927 0.980 0.997 0.997 0.997 …
. .     . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. .     . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
209     0.022 0.092 0.156 0.331 0.550 0.708 0.793 0.864 0.909 0.941 0.959 …
210     0.034 0.101 0.151 0.324 0.491 0.613 0.699 0.794 0.857 0.908 0.934 …
211     0.037 0.122 0.185 0.314 0.438 0.534 0.630 0.743 0.815 0.876 0.914 …
212       1.4  1.5  1.5  1.5  1.5  1.6  1.6  1.5  1.4  1.5  1.5  1.5
213        12   12   12   12   16   16   17   17   14   13   12   13
```

Meaning of each item in Table 5.4:

line number(s)	Item	Meaning
1	#	Starting mark
	725610	A unique number (WMO) for the wind measurement station
	US	Country
	NE	State
	SIDNEY	Name of the wind measurement station
2	41 6 *N*	Latitude (41° 6' N)
	102 59 W	Longitude (102° 59' W)
	1312	Elevation (m)
	19770101	Beginning record date (yyyymmdd)
	20001231	Ending record date (yyyymmdd)
	AUU	A three letter code containing record information Not used in the current database
3-18	Wind direction frequency (%) by month (12 columns) and direction (16 rows). See Table 5.1.	
19	Calm frequency (%) by month. See Table 5.1.	
20-211	Cumulative wind speed distributions for 12 months and 16 directions. See Table 5.3 and Figures 5.2 and 5.3.	
212	Average ratio of maximum mean hourly to minimum mean hourly observed wind speeds by month.	
213	Average hour of maximum wind speed by month.	

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Hydrology Submodel

The HYDROLOGY submodel of the Wind Erosion Prediction System (WEPS) uses inputs generated by other WEPS submodels such as WEATHER, CROP, SOIL, MANAGEMENT, and DECOMPOSITION to predict the water content in the various layers of the soil profile and at the soil-atmosphere interface throughout the simulation period. Accurate simulation by the other WEPS submodels requires prediction of the daily changes in soil water profiles. However, estimating soil wetness at the soil-atmosphere interface is emphasized, because it significantly influences the susceptibility of the soil to wind erosion.

The HYDROLOGY submodel of WEPS maintains a continuous, daily, soil water balance using the equation:

$$SWC = SWCI + (PRCP + DIRG) + SNOW - RUNOFF - ETA - DPRC \qquad \textbf{(5.1)}$$

where SWC is the amount of water on the soil profile in any given day (mm), SWCI is the initial amount of water in the soil profile (mm), PRCP is the amount of daily precipitation (mm), DIRG is the amount of daily irrigation (mm), SNOW is the daily snow melt minus daily snow accumulation (mm), RUNOFF is the amount of daily surface runoff (mm), ETA is the amount of daily actual evapotranspiration (mm), and DPRC is the amount of daily deep percolation (mm).

The amount of daily precipitation (PRCP) is partitioned between rainfall and snowfall on the basis of the average daily air temperature. If the average daily temperature is 0°C or below, the precipitation takes the form of snowfall; otherwise, it takes the form of rainfall.

The snow term (SNOW) can be either positive, equaling the daily snow melt, or negative, equaling the daily snow accumulation. The melted snow is treated as rainfall and added to the precipitation term in Equation 5.1 when accounting for daily runoff and infiltration. On the other hand, the accumulated snow is subtracted from the daily precipitation during the estimation of the daily soil water balance with Equation 5.1.

Simulation of soil-water dynamics on a daily basis by the HYDROLOGY submodel involves three major sequences. First, the submodel partitions the total amount of water available from precipitation, irrigation, and/or snow melt into surface runoff and infiltration. The submodel stores the daily amount of water available for infiltration into the soil profile. Second, the submodel determines the influence of ambient climatic conditions by calculating the potential evapotranspiration. Third, the submodel redistributes soil water in the soil profile on an hourly basis, which provides hourly estimations of water content in the soil profile. The submodel estimates the actual rate of evapotranspiration by adjusting the potential rate on the basis of soil water availability. Deep percolation from the soil profile is estimated to be equal to the conductivity of the lowermost simulation layer, assuming a unit hydraulic gradient.

The HYDROLOGY submodel estimates surface runoff and infiltration for each simulation day that has precipitation and/or irrigation. The submodel estimates the daily amount of water available for infiltration into the soil by subtracting the amount of daily surface runoff from the amount of daily precipitation, snow melt, and/or irrigation. The infiltration water is stored in the uppermost simulation layer, until its water content reaches field capacity. Any excess water then is added to the succeeding lower layer, where it is stored with the same maximum storage restriction. This is repeated until complete water storage is obtained. Any excess water that flows out from the lowermost simulation layer becomes a part of a deep percolation.

Potential evapotranspiration is calculated using a revised version of Penman's combination method (Van Bavel, 1966). The total daily rate of potential evapotranspiration then is partitioned on the basis of the plant leaf area index into potential soil evaporation and potential plant transpiration. The potential rate of soil evaporation is adjusted to account for the effect of plant residues in the simulation region. Furthermore, the daily potential rates of soil evaporation and plant transpiration are adjusted to actual rates on the basis of water availability in the soil profile.

The HYDROLOGY submodel uses a simplified forward finite-difference technique to redistribute soil water with the one-dimensional Darcy equation for water flow. The time step of the soil water redistribution is 1 hour, which allows for an hourly estimation of soil wetness as needed for WEPS. Knowledge of the relationship between unsaturated hydraulic conductivity and soil water content is required for solving the governing transport equations of water movement through the soil. The submodel uses Campbell's (1974) method to calculate the unsaturated hydraulic conductivity of the soil from the more readily available soil water characteristic curve and saturated hydraulic conductivity data. Because water release curve data of the soil are not always available, the submodel provides alternative options to estimate the hydraulic parameters of the water release curve that are needed as inputs to run the soil water redistribution segment of the submodel.

The HYDROLOGY submodel predicts on an hourly basis soil wetness at the soil-atmosphere interface by using a combination of two techniques. The submodel extrapolates water content to the soil surface from the three uppermost simulation layers. A numerical solution known as Cramer's rule (Miller, 1982) is used to obtain an estimate of the extrapolated water content at the soil surface by solving the three simultaneous equations that describe the relationship between water content and soil depth for the three uppermost simulation layers. The submodel also interpolates the functional relationship between surface-soil wetness and the hourly evaporation ratio.

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Management Submodel

Introduction
WEPS is expected to reflect effects of various management practices upon wind erosion. The diversity of current practices applied to cropland by land managers makes this a daunting task. However, WEPS must adequately simulate typical cultural practices to accurately assess their affects upon wind erosion control. The MANAGEMENT submodel is assigned the task of handling the cultural practices applied by land managers which affect the soil/surface "state" within WEPS.

Purpose
All cultural practices applied by land managers are by definition "human initiated". These human-controlled processes affecting the soil and field surface "state" are initiated by typical management practices such as tillage operations, planting, harvesting, irrigation, etc. Therefore, the purpose of the MANAGEMENT submodel is to model what are considered the *major* human-controllable actions that can affect the "system state" within WEPS, in particular the system state variables defining the temporal soil and surface conditions.

Objectives
The MANAGEMENT submodel objectives are:

1. To model the primary human-initiated processes that can affect a site's susceptibility to wind erosion.

2. To provide the framework necessary to process a list of specified human-initiated actions, i.e., the cultural practices applied to a field such as a tillage/crop rotation sequence.

Keeping with the WEPS philosophy, The MANAGEMENT submodel simulates processes via a physical basis if possible, incorporates the conservation of mass and energy concepts, and uses a minimum number of parameters with readily available and/or attainable values.

Assumptions and Limitations
Several assumptions and limitations have been imposed on the MANAGEMENT submodel. The reasons vary from simply limiting the scope of the submodel, to inadequate knowledge of specific processes that may have a significant impact on the soil and/or surface. Here is the list of current assumptions and limitations, provided in no particular order, that impact the MANAGEMENT submodel.

1. Total soil water content within the current tillage zone is assumed to be unaffected by a tillage operation. The HYDROLOGY submodel is expected to handle changes in surface water content and therefore appropriately represent the usual rapid drying of the surface layer following tillage.

2. Tillage speed is not included as an independent variable affecting how a tillage operation modifies the soil and surface. A "typical" tillage speed is assumed for each tillage operation upon which the affects upon the soil and surface are based. Future versions of the MANAGEMENT submodel may incorporate tillage speed if sufficient data becomes available to model its effects upon the soil and surface.

3. Tillage depth is assumed to not influence how a tillage operation affects the soil and surface except for determining which soil layers are directly affected by a tillage operation. Again, the MANAGEMENT submodel may be extended to incorporate tillage depth effects if sufficient data becomes available in the future.

4. Effects of tillage operations on soil layers below the tillage depth are not considered, i.e., subsoil compaction below the tillage zone due to tillage. This will be addressed in a future release of the MANAGEMENT submodel.

5. Effects of a management operation are assumed homogeneous within a subregion. Effects due to tractor tires will not be considered. Certain zone-related tillage operations, such as row cultivator, will be treated in a manner such that the result will be "averaged" or "equivalent" values which represent the homogeneous region.

6. Emergency tillage, for wind erosion prevention or control, and strip cropping practices is considered in WEPS by specifying multiple separate, non-contiguous homogeneous subregions.

7. Ridge and dike geometric specifications (oriented roughness) will be provided by the user. If the tillage depth specified is not sufficient to create or destroy them (for a particular tillage operation that does so), the MANAGEMENT submodel will modify the tillage depth accordingly to obtain the desired ridge and/or dike specifications. Tillage operations that do not modify the current ridge and/or dike specifications will not do so (i.e., ridge tillage equipment).

8. Soil tillage depths will be adjusted to the nearest soil layer boundary. This will ensure that the most recent tillage operation modifications on the soil "state" are adequately represented. In the future, soil layer boundaries may be adjusted appropriately to accommodate tillage depths that would split a soil layer, i.e., a new layer boundary would be created at the prescribed tillage depth.

9. Aggregate stability and aggregate density are assumed to be unaffected by tillage operations. This decision is based on limited field data analysis. Future research may provide statistically significant affects that could then be modeled. These properties may still change among soil layers within the tillage zone due to aggregate mixing among layers caused by tillage operations.

Submodel Description

The approach taken within the MANAGEMENT submodel to deal with the variety of land management actions was to:

1. Identify the primary physical processes involved.

2. Represent individual management operations as a sequence of those primary physical processes.

3. Develop a MANAGEMENT file format allowing the input of user-specified sequences of management operations, i.e., a management practices/crop rotation file.

All operations modeled within the MANAGEMENT submodel fall within the following defined management categories as listed in Table 5.5.

Table 5.5. Management operation classes.

Operation Class	Description
Primary tillage	Tillage performed to primarily reduce surface residue, increase short-term infiltration rates, loosen subsoil hardpans, and control weed growth. Usually after-harvest tillage operations fall in this category.
Secondary tillage	Tillage typically performed in preparation for seeding or planting operations. Usually these operations are intended to smooth the soil surface, reduce the average aggregate size, and control weed growth if present.
Cultivation	Tillage specifically designed to eliminate weed growth after crop germination.
Planting/Seeding	Operations required to plant or seed a crop into a field.
Harvesting	Operation to remove biomass from a field. Biomass removed may be grain, root material, or the entire above ground biomass.
Irrigation	The artificial application or addition of water to the soil.
Fertilization	The application or addition of specific nutrients to a soil.
Burning	The removal of surface biomass with fire.
Grazing	The removal of surface biomass via livestock.

When a management or tillage operation is performed, it is simulated through a group of individual physical processes that represent the total effects of that operation. The basic individual physical processes to be modeled within the MANAGEMENT submodel of

WEPS have been grouped according to the target of their actions and outlined in Table 5.6.

Table 5.6. MANAGEMENT submodel processes.

Action	Process	Description
Soil Mass Manipulation	Crush	The application of forces to the soil to modify the soil aggregate structure by breaking down soil aggregates.
	Loosen/ Compact	The process of decreasing soil bulk density and increasing porosity (incorporation of air) or the inverse process of increasing soil bulk density by removing air from the soil.
	Mix	The process of uniting or blending of soil layer properties, including biomass.
	Invert	The reversing of the vertical order of occurrence of soil layers within the current specified tillage zone.
Surface Manipulation	Ridge/Dike	The process of creating or destroying ridges and/or dikes (oriented surface roughness).
	Roughen	The process of modifying the random surface roughness.
	Crust	The process of modifying the soil surface crust characteristics.
Biomass Manipulation	Bury/Lift	The process of moving above ground biomass into the soil or the inverse process of bringing buried biomass to the surface.
	Cut	The process of cutting standing biomass to a prescribed height.
	Drop	The process of moving a portion of the standing biomass to the soil surface.
	Kill	The death of live biomass.
	Remove	The removal of biomass from the system (harvest, grazing, and burning).
Soil Amendments	Fertilize	Addition of nutrients to the soil.
	Plant	Addition of seeds/plants to the soil.
	Irrigate	Addition of water to the soil.

The underlying philosophy behind the MANAGEMENT submodel was to attempt to develop physical law based representations, if possible, for each of the chosen physical processes.

These processes are assumed to be independent with respect to each other and are to be simulated sequentially, even though many of them occur simultaneously in the real world. The order they are initiated in the submodel is dependent upon the specific operation.

The list of management operations performed for a given management plan (crop rotation or cyclical management practices) on a homogeneous region (subregion) is specified in a MANAGEMENT input file. The MANAGEMENT submodel checks on a daily basis for any operations to be performed on that day. If operations are needed, the MANAGEMENT submodel will execute the specified routines required to simulate the effects of those operations as instructed in the MANAGEMENT input file. When the last operation is performed for that particular crop rotation cycle, the same sequence will be repeated for the next year(s) of simulation.

A single MANAGEMENT input file may include multiple management operation lists, one for each subregion being simulated.

Crop Submodel

Introduction
The primary purpose of the WEPS plant growth submodel (CROP) is to obtain realistic estimates of plant growth so that the influence of vegetative cover on soil loss by wind erosion can be properly evaluated. The CROP submodel (Retta and Armbrust, 1995), was adapted from the Erosion Productivity Impact Calculator (EPIC) crop growth model (Williams, et.al, 1990). Additional capabilities and modifications have been developed and incorporated into the CROP submodel to meet the need for predicting effects of a growing crop on wind erosion. Young seedlings provide some protection from wind erosion. However, not all plant parts are equally effective. Stems of young plants, on a per-unit area basis, are roughly 10 times more effective than leaves in depleting wind energy. Other differences between leaves and stems are that, leaves are more sensitive to sandblast damage than are stems; and leaf and stem residues decompose at different rates. To properly account for these differences the CROP submodel gives daily estimates of leaf and stem growth in mass and area. At harvest, the ‘grain’ is removed and the ‘straw’ may consist of leaves, stems, and ‘chaff’. In most case the leaf and ‘chaff’ residue is short-lived and only the stem residue may provide protection on a longer-term basis. The CROP submodel gives estimates of the amount of leaf, stem, ‘grain’, and ‘chaff’ mass produced on a daily basis. An important consideration is the effect of plant density on the amount of cover provided by growing seedlings during the early vegetative growth period. Many management practices leave the soil vulnerable to the forces of wind erosion prior to seeding until the growing plants develop sufficient cover. During the period from emergence to the development of adequate cover, the amount of cover is directly proportional to the number of seedlings per unit area. The higher the number of plants per unit area the greater the cover provided by the growing vegetation. To account for the differences in cover due to initial plant density, the leaf and stem area indexes at emergence (which are used by the EROSION submodel in computations of soil loss) are calculated by multiplying the initial areas per plant by the number of seedlings per unit area. Thus the greater the number of seedlings per unit area at emergence, the greater the protection provided by the young seedlings from wind erosion. The CROP submodel uses data inputs of plant, weather, hydrology, and management to estimate leaf mass, stem mass, reproductive mass, yield mass, ‘chaff’ mass, and root mass of ‘live’ plants (crops) on a daily basis. Other plant characteristics estimated daily are: root mass by soil layer, rooting depth, plant height, and canopy cover.

Phenological development
Phenological development of the crop is based on growing-degree-day (GDD) accumulation. The crop parameter file for CROP contains, for each crop, the potential GDDs from planting to physiological maturity and the relative GDDs from planting to emergence, to the start of the reproductive phase, and to the start of leaf senescence. CROP uses the same procedures as EPIC for simulating annual or perennial plants, and winter or summer crops. Annual plants 'grow' from planting to the date when the accumulated GDDs equal the potential

GDDs for the crop. For annual winter crops, such as wheat, GDD accumulation (therefore growth) does not occur during the period of dormancy. Perennial crops maintain their root systems throughout the year, although the plant may become dormant after a frost. After the end of dormancy, plants start growing when the average daily air temperature exceeds the base temperature of the plant.

Emergence
Emergence occurs when the GDD accumulation from date of planting equals 6% of the seasonal GDD. CROP does not account for effects of soil temperature, soil water, soil crusting, soil strength, seeding depth, soil removal or deposition caused by wind erosion, which can influence germination, seedling emergence, survival, and growth.

Biomass Production
Shortwave radiation at the top of the canopy is multiplied by the factor C to estimate the amount of photosynthetically active radiation (PAR). The amount of PAR intercepted which is calculated using Beer's Law, is multiplied by a biomass efficiency factor to obtain net daily dry biomass production.

Growth Constraints
Potential growth and yield seldom are achieved, because of stress caused by sub-optimal conditions. The CROP submodel adjusts daily biomass and area growth for water, temperature, and nutrient stresses. Water, temperature, and nutrient stress factors range from 0, where no growth will occur, to 1 for no limitation in growth. For any simulation day, the minimum value of the water, nutrient, or temperature stress factor adjusts daily produced biomass.

References

Retta, A. and D.V. Armbrust.. 1995. WEPS technical documentation: Crop submodel. SWCS WEPP/WEPS Symposium. Ankeny, IA

Williams, J.R., C.A., Jones, and P.T. Dyke. 1990. The EPIC Model. An Erosion/Productivity Impact Calculator: 1. Model Documentation. eds. A.N. Sharply and J.R. Williams. USDA Tech. Bulletin No. 1768.l 235pp.

Residue Decomposition Submodel

Model Overview

The DECOMPOSITION submodel simulates the decrease in crop residue biomass due to microbial activity. The decomposition process is modeled as a first order reaction with temperature and moisture as driving variables. The total quantities of biomass remaining after harvest are partitioned between standing, flat, buried, and root pools. Below ground biomass decomposition is calculated for each soil layer.

Standing, flat, buried, and root biomass is accounted for in separate pools. Also, since residue decomposition can require a long period of time, crop residue biomass from sequential harvests is accounted for in separate pools. Biomass from the most recently harvested crop will be in pool one, biomass from the penultimate crop in pool two, and there is a third pool for flat biomass. On a day of harvest, any biomass remaining from a previous crop is moved into the older age pools and residue from the current crop is moved into pool one. Decomposition rates for biomass pools one and two will be appropriate for the specific crops while biomass pool three will have a decomposition rate that reflects a slow rate of decomposition.

Decomposition

The general decomposition equation is a simple first order rate loss equation:

$$M_t = M_o * \exp^{-k\,CUMDD} \tag{5.2}$$

where M_t is the present quantity of biomass (kg m^{-2}) in the standing, surface, buried, or root pools; M_o is the initial biomass (kg m^{-2}); k is a crop specific rate constant used to calculate residue biomass changes (kg kg^{-1} day^{-1}); and CUMDD is cumulative decomposition days (day): a weighted-time variable calculated from functions of temperature (TCF) and moisture (WCF). WEPS uses the same k-value for the standing, flat, buried, and root residue pools. Optimum moisture and temperature conditions result in the accumulation of 1 decomposition day for each day of the simulation. When moisture or temperature limit the rate of decomposition, the minimum of the moisture or temperature functions is used to accumulate a fraction of a decomposition day.

In the DECOMPOSITION submodel biomass loss is actually calculated using the numeric form of equation 1 as follows:

$$M_t = M_{t-1} * (1 - k * MIN(TCF, WCF)) \tag{5.3}$$

where M_{t-1} is the quantity of biomass (kg m^{-2}) on the previous day. Functions for TCF and WCF are adjusted depending on residue placement (standing, flat and below ground). The moisture function for standing residues is:

$$WCF_s = \frac{RAIN}{4} + 0.4 * WCF_{s,ti1} \tag{5.4}$$

where $WCF_{s,\,t-1}$ is the moisture function for standing residues on the previous day. It is based on the precipitation depth RAIN (mm), with 4 mm of rainfall considered to saturate the standing residues. Greater than 4 mm rainfall results in WCF_s being set to 1. Residual moisture in the residues is considered to decrease by 60 % each day following the wetting event. After more than 4 dry days in a row $WCF_s = 0$.

Both precipitation and soil moisture influence the decomposition of flat residue. The maximum of either the above estimate of WCF_s or a function WCF_f that considers the flat residues to be in equilibrium with the upper soil layer is used. WCF_f is calculated from the soil water content of the upper soil layer, Θ_1, and the optimum water content for decomposition. Field capacity, Θ_{fc}, was implemented as the optimum water content:

$$WCF_f = \frac{\Theta_1}{\Theta_{1,\,fc}} \tag{5.5}$$

The moisture function for buried residues and roots is,

$$WCF_g(NZS) = \frac{\Theta_{NZS}}{\Theta_{NZS,\,fc}} \tag{5.6}$$

where Θ_{NZS} is the water content of layer NZS and $\Theta_{NZS,\,fc}$ is the field capacity of layer NZS.

The function to calculate TCF is similar to one describing the influence of temperature on photosynthesis (Taylor and Sexton, 1972) and used by Stroo et al. (1989) for decomposition:

$$TCF = \frac{2(T-A)^2(T_{opt}-A)^2 - (T-A)^4}{(T_{opt}-A)^4} \tag{5.7}$$

where T is temperature (°C), T_{opt} is the optimum temperature for decomposition (32 °C) and A is a base temperature (0 °C) below which no decomposition occurs (see Fig 5.5). For standing and flat residues TCF is calculated as the average of two TCF values: one calculated using daily maximum air temperature and a second using daily minimum air temperature. For below ground residues daily average soil temperature by layer is used.

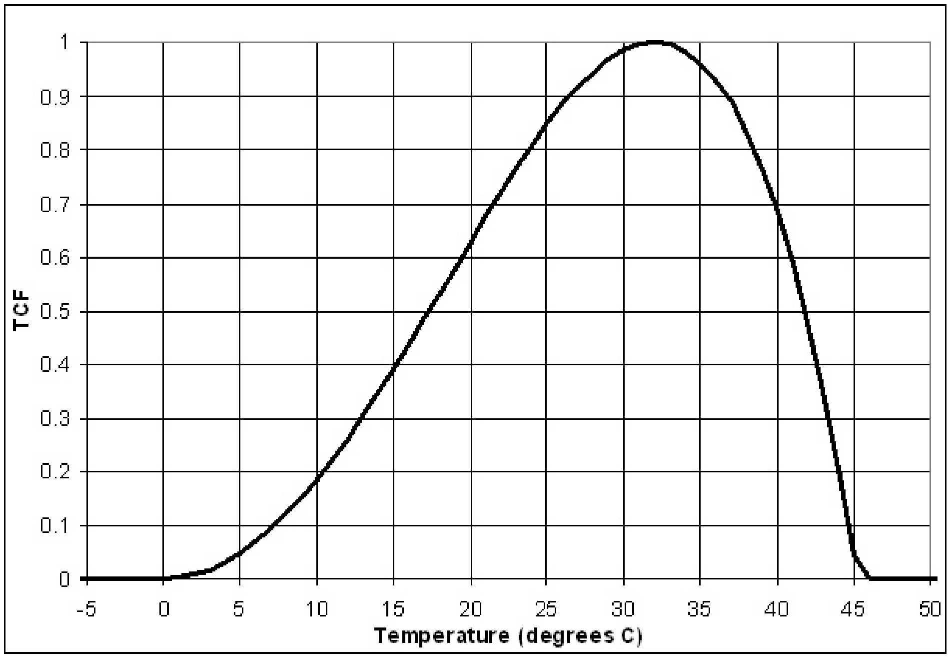


Figure 5.4. Plot of Equation 5.7 with a maximum temperature of 32°C and a base temperature of 0°C.

Decline in Standing Residue Biomass and Population

Standing residue losses occur from both microbial and physical actions (Steiner et al, 1994). Physical transfer of crop residue from the standing biomass pool will reduce both the stem population size and biomass. When the changes occur due to physical forces such as wind, snow, gravity, or wheel traffic the transfer is to the flat pool. Tillage may result in redistribution to both the flat and buried pools. A daily estimate of the standing population is required in order to evaluate stem area index (SAI) and its influence on aerodynamic resistance.

Soil Cover

Both standing and flat crop residue provide cover to the soil surface. Soil cover from standing residue is estimated from the number of stems per unit area and the stem diameter. To predict soil cover from flat residue mass an equation developed by Gregory (1982) is used.

Modifying Variables Due to Tillage Operations

On a day of tillage, the distribution of residues will change between standing, flat and buried components depending on the tillage implement being used. The MANAGEMENT submodel will need to update the current biomass for each position (standing, flat, buried, and root) in each of the three age pools (1, 2, 3). Soil surface cover is then updated from the amount of biomass remaining in the flat and standing pools.

References

Gregory, J. M. 1982. Soil cover prediction with various amounts and types of residue. Trans. ASAE. 25: 1333-1337.

Steiner, J. L., H. H. Schomberg, C. L. Douglas, Jr., and A. L. Black. 1994. Standing stem persistence in no-tillage small-grain fields. Agron. J. 86:76-81.

Stroo, H. F., K. L. Bristow, L. F. Elliott, R. I. Papendick, and G. S. Campbell. 1989. Predicting rates of wheat residue decomposition. Soil Sci. Soc. Am. J. 53:91-99.

Taylor, S. E. and O. J. Sexton 1972. Some implications of leaf tearing in musacea. Ecology 53: 143-149.

Soil Submodel

Introduction
All the soil properties that control soil wind erodibility vary with time. Hence, the objective of the soil submodel is to simulate these temporal soil properties on a daily basis in response to various driving processes. On days when wind erosion or management activities occur, the Erosion and Management submodels may also update some of the same temporal variables. The driving processes that change soil temporal properties are mostly weather related, and hence, the sequence of occurrence of individual driving processes is highly variable. Thus, the submodel must be able to update the soil variables given an arbitrary driving process and the soil conditions for the prior day. The purpose of this paper is to provide a brief overview of the major processes that are simulated, and the temporal variables that are updated by the soil submodel. For an in-depth discussion of the equations used in the Soil submodel, see the Soil Submodel Technical Document (Hagen et al., 1995).

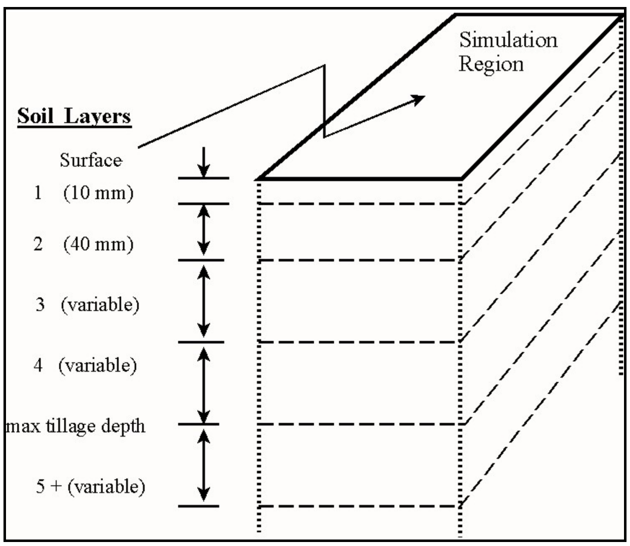


Figure 5.5. Diagram representing the spatial domain of the Soil submodel.

Spatial Regime
In the Soil submodel, the spatial regime is considered to be uniform in the horizontal direction over the simulation region, but non-uniform in the vertical direction (Fig. 5.5). Hence, the vertical direction is divided into layers in each soil profile. Some of the layer boundaries are selected to coincide with the layers determined by the NRCS Soil Survey of each soil. Layers one and two are initially set at 10 and 40 mm (0.39 and 1.57 inches), respectively, to allow simulation of sharp gradients in temporal soil properties near the surface.

Soil Layering Scheme
The hydrology and crop sub-models of WEPS depend upon the soil being stratified by layers. Hydrology moves water up and down within the soil based upon the relative wetness of adjacent layers. Crop estimates plant growth based upon several factors, one of the most important being availability of water within the root zone. It is important that WEPS keep track of now how much water is available at various soil depths. Hence, WEPS views the soil as a series of layers, each layer possibly having distinct physical characteristics but this is not necessary.

WEPS divides the soil into layers based upon National Soil Information System (NASIS) input data. The layering scheme respects the underlying NASIS data. That is, no NASIS layers are combined when creating WEPS layers. Much of the complexity of the layering process is due to the creation of the very thin top layers. The design criteria are:

10. Preserve NASIS layering, i.e. a WEPS layer cannot cross a NASIS layer boundary.

11. Try to get the first three layers to be 10, 40 and 50 mm.

12. Preserve the relative sizes, 1:4:5:5, of the top layers if the absolute size cannot be attained.

13. Divide the remaining layers into relatively uniform thicknesses, somewhat thinner at the top and thicker as depth increases.

Processes Simulated and Variables Updated

The processes simulated and the variables updated are summarized in Table 5.7. The effect of the processes on roughness is always to reduce the roughness. In contrast, many of the other variables either increase or decrease in value depending upon the prior-day value, soil intrinsic properties and the driving process. To simulate the dry stability and aggregate size distribution, for a wide range of soils, these variables were first normalized using mean and standard deviation of the variables for each soil series to give a range from 0 to 1 for each variable. The driving processes were then applied to the normalized ranges to determine the change in the normalized variable. Finally, the updated normalized values were converted to the real values of these variables.

Table 5.7. Soil submodel variable and process matrix.

	Surface Processes			Layer Processes		
Soil Temporal Variables	Rain	Sprinkler Irrigation	Snow Melt	Wet/dry	Freeze/thaw	Freeze/dry
Roughness:						
Ridge Height	X	X	X			
Dike Height	X	X	X			
Random	X	X	X			
Crust:						
Depth	X	X	X			
Cover fraction	X	X	X			
Density	X	X	X			
Stability	X	X	X	X	X	X
Loose mass	X	X	X			
Loose cover	X	X	X			
Aggregates:						
Size distribution	X	X	X	X	X	X
Dry stability	X	X	X	X	X	X
Density	X	X	X	X	X	X
Layers:						
Bulk density	X	X	X			

In summary, the Soil submodel outputs updated values on a daily basis for each of the variable listed in Table 5.7 in response to the occurrence of the various driving processes.

References

Hagen, L.J., T.M. Zobeck, E.L. Skidmore, and I. Elminyawi. 1995b. WEPS technical documentation: soil submodel. SWCS WEPP/WEPS Symposium. Ankeny, IA

Erosion Submodel

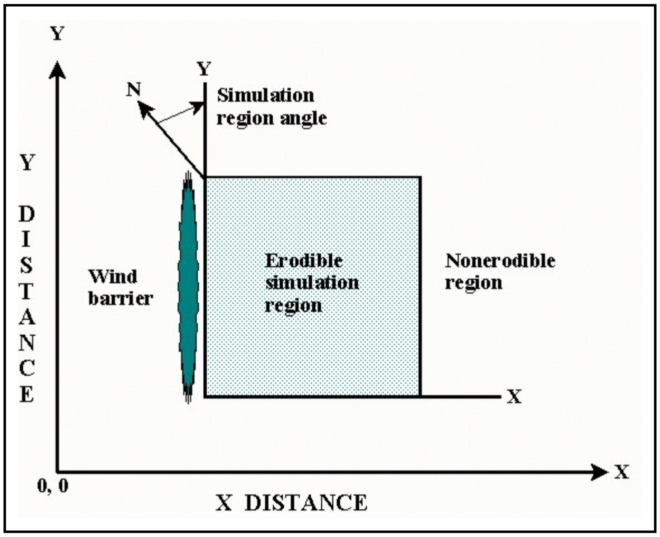


Figure 5.6. Schematic of simulation region geometry. Field orientation, end points of barriers, and opposite corners of the rectangular simulation region are input to the Erosion submodel.

Introduction

The objective of the erosion submodel is to simulate the components of soil loss/deposition over a rectangular field in response to wind speed , wind direction, field orientation, and surface conditions on a sub-hourly basis (Fig. 5.6). In WEPS 1.0 barriers maybe placed on any or all field boundaries. When barriers are present, the wind speed is reduced in the sheltered area on both the upwind and downwind sides of the barriers. The submodel determines the threshold friction velocity at which erosion can begin for each surface condition. When wind speeds exceed the threshold, the submodel calculates the loss/deposition over a series of individual grid cells representing the field. The soil/loss deposition is divided into components of saltation/creep and suspension, because each has different transport modes, as well as off-site impacts. Finally, the field surface is periodically updated to simulate the changes caused by erosion. The purpose of this paper is to provide users with a brief overview of the submodel. For an in-depth description of the equations used in this submodel, see the WEPS Erosion Submodel Technical Description (Hagen, 1995).

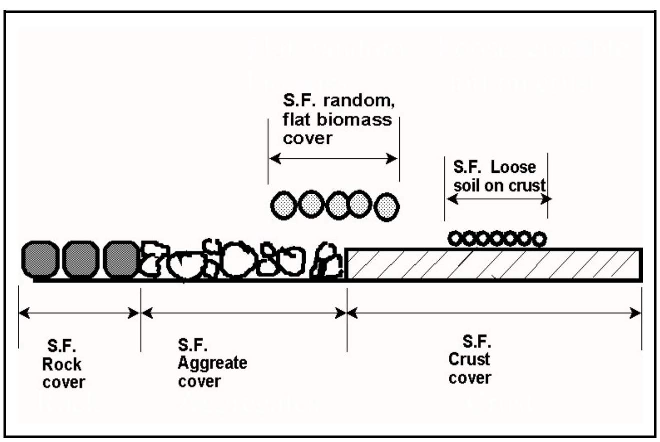


Figure 5.7. Diagram illustrating components of flat surface cover inputs to the Erosion submodel.

Surface Conditions Needed as Inputs

Surface roughness is represented by both random roughness and oriented roughness. The parameters used are standard deviation of the surface heights for random roughness and the height, width of ridge tops, and spacing of ridges for oriented roughness.

Surface cover is represented on three levels (Fig. 5.7). In the first level, surface rock, aggregates and crust comprise 100 percent of the cover. In the second level, the parameter is the fraction of the crusted surface covered with loose, erodible soil. When there is no crust, this parameter is always zero. In the third level, the parameter is the fraction of total surface covered by flat, random biomass.

The aggregate density and size distribution are input parameters that indicate soil mobility. The dry mechanical stability of the clods/crust are input parameters that indicate their resistance to abrasion from impacts by eroding soil. Surface soil wetness is also input and used to increase the threshold friction velocity at which erosion begins.

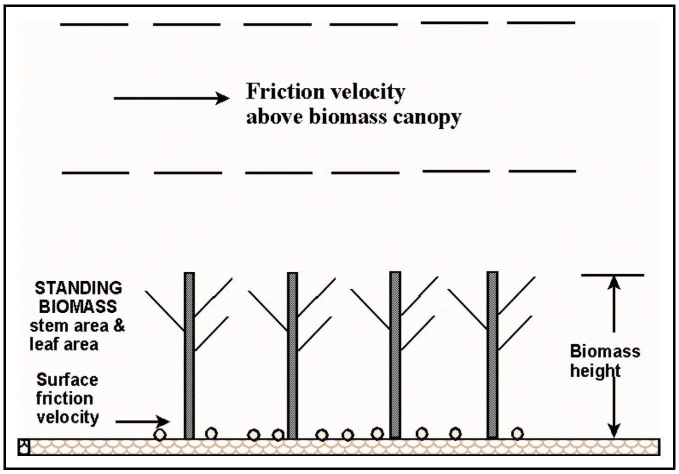


Figure 5.8. Diagram illustrating friction velocity above standing biomass that is reduced by drag of stems and leaves to the surface friction velocity below the standing biomass.

Uniformly distributed, standing biomass is 5 to 10 times more effective in controlling wind erosion than flat biomass, and thus, is treated separately. The wind friction velocity above standing biomass is depleted by the leaves and stems to obtain the surface friction velocity at the surface that is used to drive erosion (Fig. 5.8). Leaves are represented by a leaf area index and stems by a stem silhouette area index in the input parameters.

Erosion Processes Simulated

Soil transport during wind erosion occurs in three modes: creep-size aggregates, 0.84-2.0 mm (0.033 - 0.079 in.) in diameter roll along the surface, saltation-size aggregates, 0.10 - 0.84 mm (0.004 - 0.033 in.) in diameter hop over the surface, and suspension-size aggregates, < 0.01 mm (0.004 in.) in diameter move above the surface in the turbulent flow. Obviously, variations in friction velocity, aggregate density and sediment load may change the mass of aggregates moving in a given mode. Saltation and creep are simulated together, because they have a limited transport capacity that depends mainly upon friction velocity and surface roughness. The suspension component is simulated with no upper limit on its transport capacity at the field scale. A portion of the suspension component also is simulated as PM-10, i.e., particulate matter less than 10 micrometers (0.0004 in.) in diameter that is regulated as a health hazard.

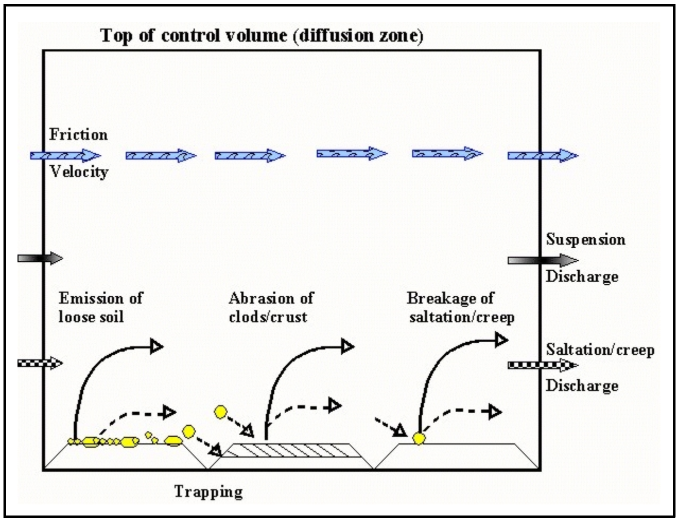


Figure 5.9. Diagram illustrating processes simulated by the Erosion submodel on a bare soil surface in an individual grid cell.

Multiple, physical erosion processes are simulated in the erosion submodel, and these are illustrated for a single grid cell in Fig. 5.9. The two sources of eroding soil are emission of loose soil and entrainment of soil abraded from clods and crust. These sources are apportioned between saltation/creep and suspension components based on the process and soil characteristics. Three processes deplete the amount of moving saltation/creep. These include trapping in surface depressions, interception by plant stems/leaves, and breakage of saltation/creep to suspension-size.

Simulation of surface rearrangement is accomplished by allowing emissions to deplete the loose soil and armor the surface in the upwind field area. In contrast, processes such as abrasion of the protruding aggregates and trapping in depressions dominate in downwind areas and lead to smoothing the surface and a build-up of loose saltation/creep. A build-up of saltation/creep often occurs, because the transport capacity may be satisfied, but abrasion of clods/crust continues to create additional saltation/creep-size soil.

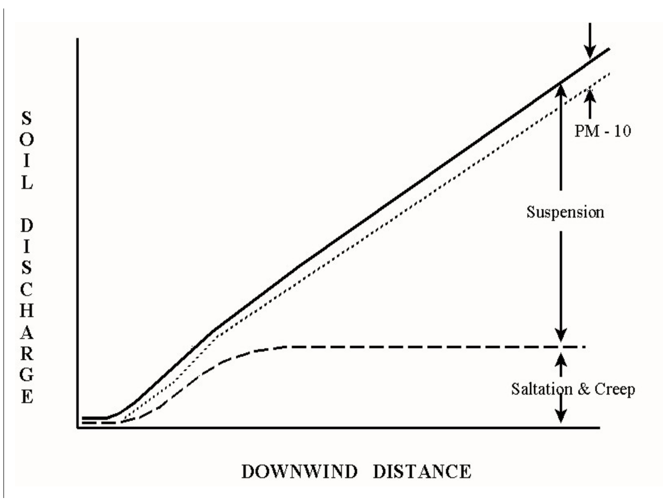


Figure 5.10. Diagram illustrating downwind transport capacity for saltation & creep, but a continuing increase in transported mass of suspension-size soil downwind.

Typical behavior of the downwind soil discharge simulated along a line transect for the saltation/creep and suspension components is illustrated in Fig. 5.10. The suspension component keeps increasing with downwind distance even though saltation/creep reaches transport capacity. This is because the sources for suspension-size soil are usually active over the entire field. These sources include emissions from impacts on loose soil, abrasion from clods/crust, and breakage from impacting saltation/creep-size aggregates. Moreover, the suspension component has a transport capacity many times larger than that of saltation/creep, so on large fields it is the ‘freightliner’ for moving soil and saltation/creep is merely the ‘pickup truck’.

Outputs

The Erosion submodel calculates total, suspension, and PM-10 soil loss/deposition at each grid cell in the field. The grid cell data are summarized in other parts of WEPS and reported to users as averages over the field for selected periods. The submodel also calculates the components of soil discharge crossing each field boundary. These are reported to users based on the size ranges of aggregates as saltation/creep, suspension, and PM-10. These latter outputs are useful for evaluating off-site impacts in any given direction from the eroding field.

References

Hagen, L.J. 1995. Wind Erosion Prediction System (WEPS) Technical Description: Erosion submodel. IN Proc. of the WEPP/WEPS Symposium. Soil and Water Conserv. Soc., Des Moines, IA.

Soil Database

The soil data for WEPS is derived from the National Soil Information System (NASIS) - developed and maintained by the USDA-NRCS. Below is a list of the data elements which are obtained from NASIS and a brief description of each.

NASIS Physical Name	Descriptive Name (units) - definition - data type
state	State name - character
county	County name - The name of the County - character
ssaname	Soil survey area name - The name given to the specified geographic area (e.g., soil survey area) - character
ssaid	Soil survey area symbol - A symbol that uniquely identifies a single occurrence of a particular type of area (e.g Lancaster Co., Nebraska is NE109) - character
musym	Map Unit Symbol - The symbol used uniquely identify the soil map unit in the soil survey - character
compname	Soil component name - The correlated name of the map unit - character
comppct	Soil component percent (%) - The percentage of the component of the map unit - integer
locphase	Local phase - A phase criterion used at a local level to help identify soil components - character
taxorder	Soil taxonomic order - The soil order of the soil component name - character
slope	Slope gradient (%) - The difference in elevation between two points - float
albedodry	Albedo of the bare dry surface soil - The estimated ratio of the incident shortwave (solar) radiation that is reflected by the air dry, less than 2 mm fraction of the soil (unitless) - float
surffrag	Surface fragment cover - The fraction of the surface area covered by rock

greater than 2.0 mm (m3/m3).

texture Soil texture - An expression, based on the USDA system of particle sizes, for the relative proportions of various size groups - character

tvalue Soil Loss Tolerance (T factor) - The maximum amount of erosion at which the quality of a soil as a medium for plant growth can be maintained. (Tons/acre/year)

hzdept Depth to top of horizon (cm) - The distance from top of the soil to the top of soil horizon - integer

hzdepb Depth to bottom of horizon (cm) - The distance from top of the soil to the base of soil horizon - integer

claytotal Clay (%) - Mineral particles less than 0.002 mm in equivalent diameter as a weight percentage of the total soil - float

sandtotal Sand (%) - Mineral particles 0.05 to 2.0 mm in equivalent diameter as a weight percentage of the total soil - float

sandco Coarse sand (%) - Mineral particles 0.5 to 1.0 mm in equivalent diameter as a weight percentage of the total soil - float

sandmed Medium sand (%) - Mineral particles 0.25 to 0.5 mm in equivalent diameter as a weight percentage of the total soil - float

sandfine Fine sand (%) - Mineral particles 0.10 to 0.25 mm in equivalent diameter as a weight percentage of the total soil - float

sandvf Very fine sand (%) - Mineral particles 0.05 to 0.10 mm in equivalent diameter as a weight percentage of the total soil - float

fragvol Rock fragments by volume (%) - The volume of the horizon occupied by 2 mm or larger fraction - integer

dbthirdbar Bulk density 1/3 bar (Mg/m^3) - The oven dried weight of the less than 2.0 mm soil material per unit volume at a tension of 1/3 bar - float

dbovendry Bulk density oven dry (Mg/m^3) - The oven dried weight of the less than 2.0 mm soil material per unit volume - float

wthirdbar Water 1/3 bar (%) - The amount of soil water retained at a tension pf 1/3 bar (33 kPa), expressed as a percentage of the less than 2 mm, oven-dry soil weight - float

wfifteenbar Water 15 bar (%) - The amount of soil water retained at a tension pf 15 bar (1500 kPa), expressed as a percentage of the less than 2 mm, oven-dry soil weight - float

ksat Saturated hydraulic conductivity (µm/s) - The amount of water that would move vertically through a unit area of saturated soil in unit time under unit hydraulic gradient - float

lep Linear extensibility percent (%) - The linear expression of the volume difference of the natural soil fabric at 1/3 bar water content and oven dryness. The volume change is reported as a percent change for the whole soil. - float

cec7 Cation exchange capacity (meq/100 g) - The amount of exchangeable cations that a soil can adsorb at pH 7.0 - float. If the soil has a pH < 5.5, the column is blank, otherwise the effective cation exchange capacity will be listed.

ecec Effective Cation exchange capacity (meq/100 g) - The sum of NH4OAc extractable bases plus KCl extractable aluminum used for soils that have pH < 5.5 - float. If the soil has a pH < 5.5, the effective cation exchange capacity will be listed, if not the column is blank.

om Organic matter (%) - The amount by weight of decomposed plant and animal residue expressed as a weight percent of the soil material - float

caco3 Calcium carbonate equivalent (%) - The quantity of Carbonate (CO3) in the soil expressed as CaCO3 as a weight percentage of the < 2 mm soil - integer

ph1to1h2o Soil Reaction - pH (unitless) - A numerical expression of the relative acidity or alkalinity of a soil using the1:1 soil to water method. - float. If the soil is a mineral soil, the pH will be listed, if not, the column is blank.

ph01mcac12 Soil Reaction - pH (unitless) - A numerical expression of the relative acidity or alkalinity of a soil using the 0.01M calcium chloride method. - float. If the soil is a Histosol, the pH will be listed, if not, the column is blank.

Note that there are two entries for pH and two for CEC. Only one of each of these should be populated depending on the type of soil.

Downloading Soil Data

This section describes how to download soil data from the NRCS Soil Data Mart and how to extract it for use within WEPS. A Microsoft Access database is available for importing the data in the export file. You must have Microsoft Access 97 or later installed on your PC.

Soil data for NRCS and most other users in the US, is currently available for download from the NRCS Soil Data Mart at: http://soildatamart.nrcs.usda.gov/ . To obtain soil data for a Soil Survey Area of interest, go to the Soil Data Mart and click 'Select State' at the top of the Soil Data Mart screen. Select the desired state then click 'Select Survey Area' or 'Select County'. Select the soil survey area, then click 'Download Data'. On the download screen select 'Tabular Data Only', select the version of Microsoft Access on your computer, and enter your e-mail address, then click 'Submit Request'. You will see a message stating "Your request has been logged. You will be notified via e-mail as soon as your request has finished being processed." At a later time you will receive an e-mail with a link to download the export file. The format of an export file name is: soil_ssasymbol.zip, where ssasymbol is the symbol of the corresponding soil survey area.

After the export file has been copied to your PC, it must be unzipped using either WinZip or a similar program. For additional information, please see the file named README.txt in the root directory that is created by unzipping the export file. Each zip file for additional soil survey areas should be copied and unzipped into individual directories. When an export file is unzipped, the following directory hierarchy is produced in the directory to which the export file was unzipped:

tabular
spatial

The top level directory contains the following files:

soil_metadata_ssasymbol.txt - Federal Geographic Data Committee (FGDC) metadata in plain ASCII format.

soil_metadata_ssasymbol.xml - the same FGDC metadata in XML format.

README.txt - a text file containing additional information.

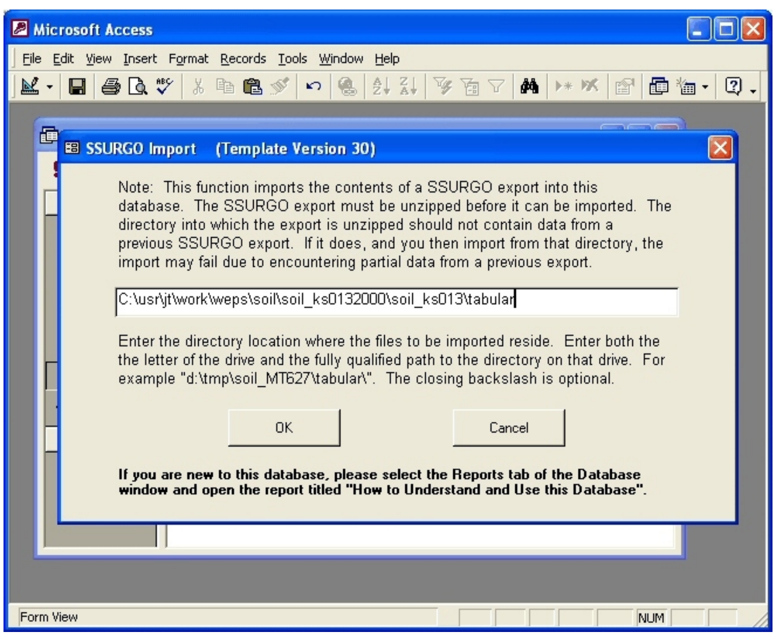
The root directory will also contain a zipped, empty MS Access SSURGO template database, if one was requested as part of the download. The non-extension part of the zipped template database file name varies, but if one was included, it will be the only file in the top level directory with an extension of "zip". This file should be unzipped as well.

The directory "tabular" contains any tabular data that was requested. The directory "spatial" contains any spatial data that was requested. Note that spatial data is not required or recommended (due to file size) for WEPS. It is possible to request tabular data without including the corresponding spatial data, and vice versa.

Tabular data is provided as a set of ASCII delimited files. Each file corresponds to a table in the SSURGO 2.1 data model. The tabular data isn't particularly useful until it has been imported into an MS Access SSURGO template database. If a template database was not included in the export file, you can download one from the following URL:

http://soildatamart.nrcs.usda.gov/templates.aspx

Load the template file into MS Access. A ‘SSURGO Import’ screen will display asking for the full path to the tabular data directory (see figure below). Type the full path of the tabular directory and click ‘OK’. A list of database tables will appear and a folder will be created in the top level directory (with the non-extension part of the template name). At the same time, an MS Access database file (*.mdb) which contains the data required for WEPS, will be created in the template folder. To import more than one soil survey area into a single MS Access database, run the Import macro specifying the full path to the directory the SSURGO data was uncompressed into. Repeat the Import macro for each area desired. When done, save the template database with the imported data to a new name (*.mdb).



Using SSURGO Data With WEPS

Within WEPS, open the "**Configuration**" window, then click the "**Directories**" tab. Fill out the full path and SSURGO soil database file name (*.mdb) for "**Soil DB**" and close the configuration window. Selecting the Soil Template folder  at the bottom of the main WEPS screen will display the list of soil survey areas to choose from. Select the desired soil survey area and select the soil map unit and component for the simulation run. If the SSURGO database is not populated with data required by WEPS you will get an error message when selecting that soil. More detailed information on selecting soils, see the "**Interface Reference: Choosing a Soil**" section of the WEPS User Manual.

Crop Database

Introduction

In the WEPS plant growth submodel biomass is converted from solar radiation and partitioned to root and 'shoot' parts (Fig. 5.11). The shoot mass is partitioned into leaf, stem, and reproductive masses. Finally the reproductive mass is partitioned into grain and chaff parts. Development of the crop in WEPS is a function of the heat unit index, which is the ratio of the cumulated growing degree days at any time to the seasonal growing degree days. The crop reaches maturity when the heat unit index is 1. To perform these and other operations the WEPS plant growth model uses crop parameters. A short description of all the database parameters used in the WEPS plant growth model is below. The parameters consist of a mixture of plant growth, decomposition, and other related information used to simulate plant growth and decomposition in the WEPS model.

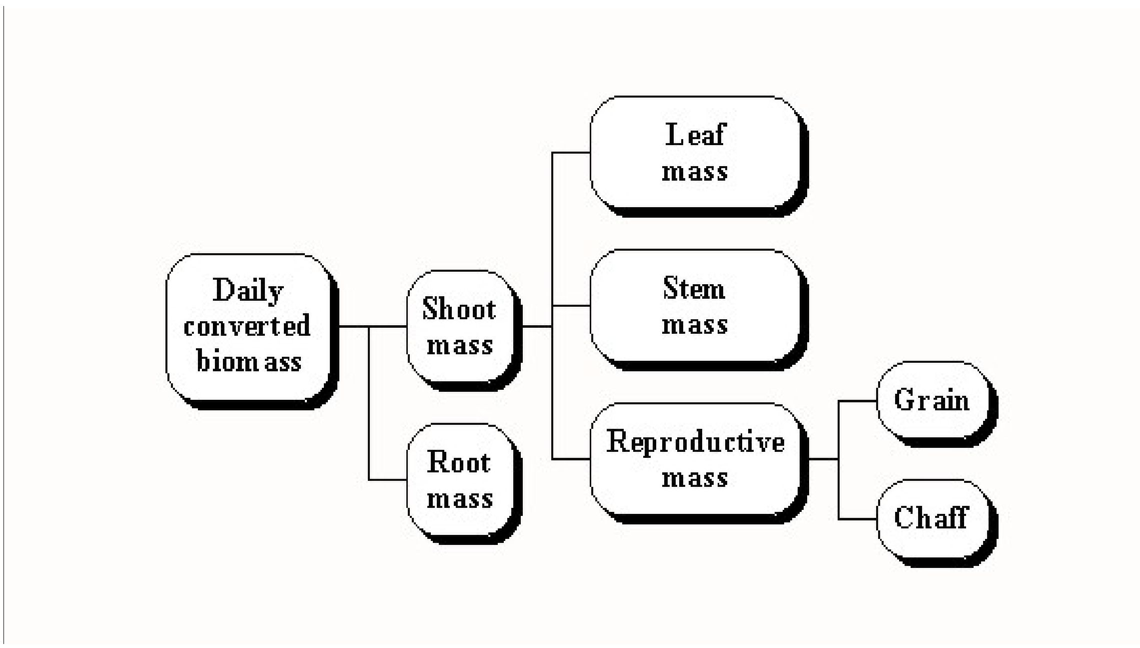


Figure 5.11. Schematic of biomass partitioning in WEPS.

Crop Parameters

Accessing the crop parameters: Many of the crop database parameters can be accessed (i.e., viewed or modified) through the WEPS crop rotation editor. Double clicking on the folder icon, on the left side of the main screen management box, will bring up the management crop rotation editor. This allows the user to modify management scenarios and save them to other file names. The crop parameter window can be accessed by clicking on the folder icon next to a listed crop on the left side of the 'Crop' column of the MCREW window.

The crop parameters are grouped in 6 tabs. Many of the parameters are assumed to be crop specific, and therefore should not be changed unless the user establishes that a parameter(s) does not work for their condition. At the top of the crop parameter window is the 'Crop Name' selection list. Clicking on the down arrow displays a list from which to select a crop. This is a list of the common name of the crop, which may be followed by additional descriptors when there are multiple entries for the same crop. For example, 'soybeans, MG 0, 95 days' means that the name of the crop is soybeans belonging to maturity group 0 , and takes about 95 days to mature.

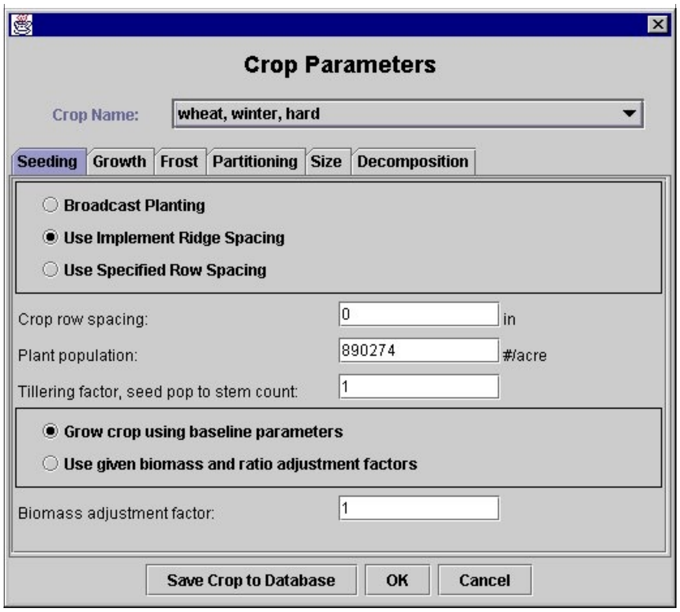


Figure 5.12. Seeding tab window.

<u>Seeding tab (Fig 5.12):</u> This tab has two variables, 'plant population' and 'tillering factor', that are read from the crop database. Plant population is the number of plants or seedlings per unit area. The model assumes 100% germination rate. The tillering factor is the number of tillers per plant. Normally the model is run with the 'Biomass adjustment factor' set to 1.0. However, the model can be run by entering the desired biomass adjustment factor. This choice can be made by clicking on the 'use given biomass and ratio adjustment factors' circle and entering the desired biomass adjustment factor. It is recommended that the use of a biomass adjustment factor be limited to cases when it can be demonstrated that biomass production was influenced by processes other than those simulated in the model. The default plant population (seeding rate) can be changed to suit the conditions being simulated. As mentioned above plant population density will have an impact on amount of vegetative cover, and therefore erosion rates, during the early part of the growing period. It can also have an impact on 'yield'.

<u>Growth tab (Fig. 5.13):</u> This tab displays ten parameters from the crop database. First the user must select the mode of calculation; whether to use the 'days to maturity'(DTM) mode, or the 'seasonal growing degree days (GDD_s)'. This is done by clicking the appropriate circle labeled 'Crop matures on average in Days shown' or 'Crop Matures in Heat Units shown'. GDD_s is the total growing degree days from planting to physiological maturity. In the GDD_s mode the user can either use the default GDD_s or supply another value. In the

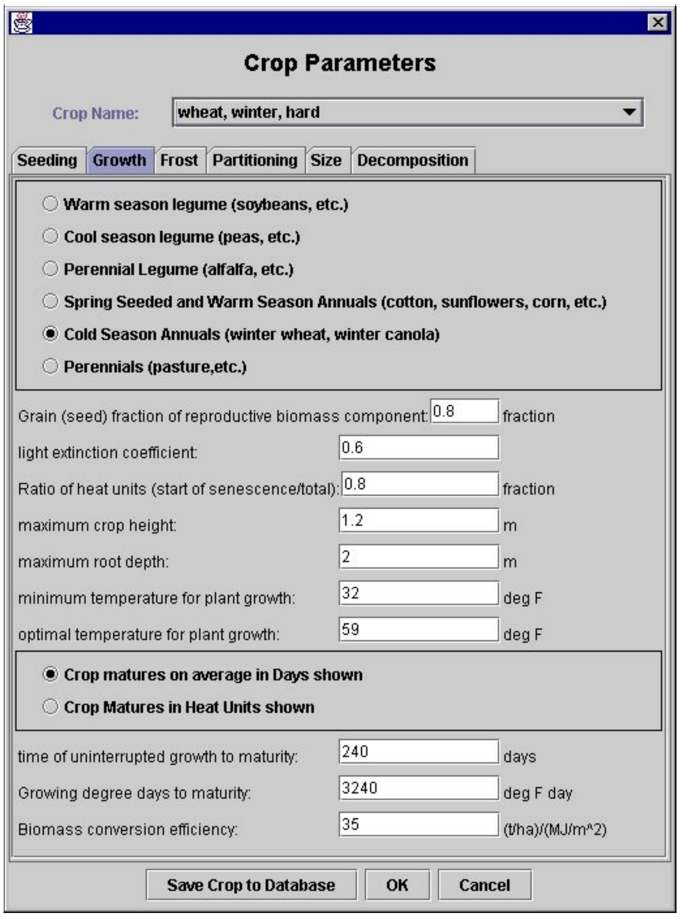


Figure 5.13. Growth tab window.

DTM mode the model computes GDD_s internally. A brief description of DTM follows. For annual crops DTM is the number of days from planting to physiological maturity. For perennial crops (e.g. alfalfa), DTM is the number of days from start of spring growth to physiological maturity of seed. For perennials, the date of spring planting (or start of spring growth) is not a data entry, but calculated internally in the Crop submodel. For root and vegetable crops, DTM is the number of days from the planting/transplanting date to market 'maturity'. Similarly, for tropical fruit crops (e.g. pineapple) DTM is the number of days from planting to market maturity of fruit. For sugarcane, DTM is the number of days from planting to the time when the cane is ready for cutting. For cover crops DTM is the time from planting at the normal planting time to physiological maturity. If a user feels that the default value of DTM is either too long or too short then the user should replace it to more correctly represent the cultivar or variety being simulated. Since DTM is used in internal computations of GDD_s it determines the length of the growing season. If the user chose the GDD_s mode then the user must ensure that the default GDD_s applies to the variety being simulated. In most cases it is recommended that the DTM method should be used, most users may be more familiar with the number of days a crop may take to mature than with how many growing-degree-days a crop takes to mature. However, the GDD_s method should be used for cover crops that are planted out of season. It is recommended that most of the remaining parameters in this tab should not be changed without proper evaluation.

A brief definition of the parameters in this tab is below:

<u>Grain (seed) fraction of reproductive biomass component</u>: Harvestable fraction of reproductive biomass. For grain crops the reproductive mass is the ratio of grain mass to

reproductive mass (grain/(grain+chaff)). For corn the 'chaff' will include the husk and the shank. For many field crops a value of 0.8 is used.

light extinction coefficient: A measure of how much of the light energy is transmitted through a canopy. This parameter is a constant in the equation used to convert light energy into biomass. Values may range from 0.3 to 0.6 for crops with upright leaves, and from 0.6 to 1.05 for crops with horizontal leaves.

Ratio of heat units (start of senescence/total): This parameter determines when senescence will start (e.g. a value of 0.8 indicates that senescence will start when 80% of the growing season is completed).

maximum crop height: The height a plant can reach under ideal growing conditions.

maximum root depth: The depth that the root of a plant can reach under ideal growing conditions.

minimum temperature for plant growth: The average daily air temperature below which the model will not allow plant growth (the temperature stress factor is 0.0).

optimal temperature for plant growth: The average daily air temperature at which the model will allow maximum growth (the temperature stress factor is 1.0).

time of uninterrupted growth to maturity: This label is misleading and should be changed to read: days from planting to physiological (or market) maturity. For annual grain crops, the average number of days from planting to maturity of seed; for vegetable, fruit and root crops, sugarcane, and tobacco it is the number of days from planting (or ratooning) to harvest; for perennials (e.g. alfalfa) it is the number of days from spring growth to maturity of seed.

Growing degree days to maturity: For annual grain crops, the average seasonal growing-degree-days from planting to maturity of seed; for vegetable, fruit and root crops, sugarcane, and tobacco it is the average seasonal growing-degree-days from planting (or ratooning) to harvest; for perennials (e.g. alfalfa) it is the average seasonal growing-degree-days from spring growth to maturity of seed.

Biomass conversion efficiency: Energy to biomass conversion parameter at ambient CO_2 levels. This parameter determines how effective a crop is in converting photosynthetically active radiation into structural biomass. This parameter may be changed based on field experimentation.

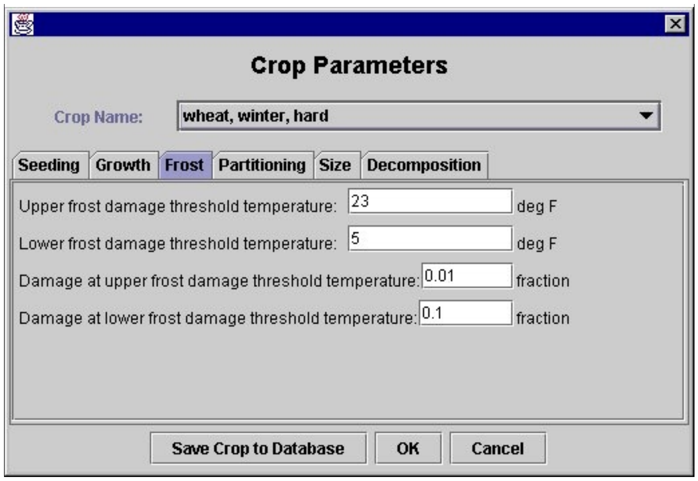


Figure 5.14. Frost tab window.

Frost tab (Fig. 5.14): The Crop submodel reduces green leaf area in response to frost. The frost parameters determine the shape of a sigmoid curve used in assessing rate of green leaf area reduction in response to temperatures below freezing (Fig. 5.15).

Note: Changing parameters on the 'Frost' tab is not recommended unless the user completely understands their derivation and the resulting effect of the changes. Contact WERU for more assistance.

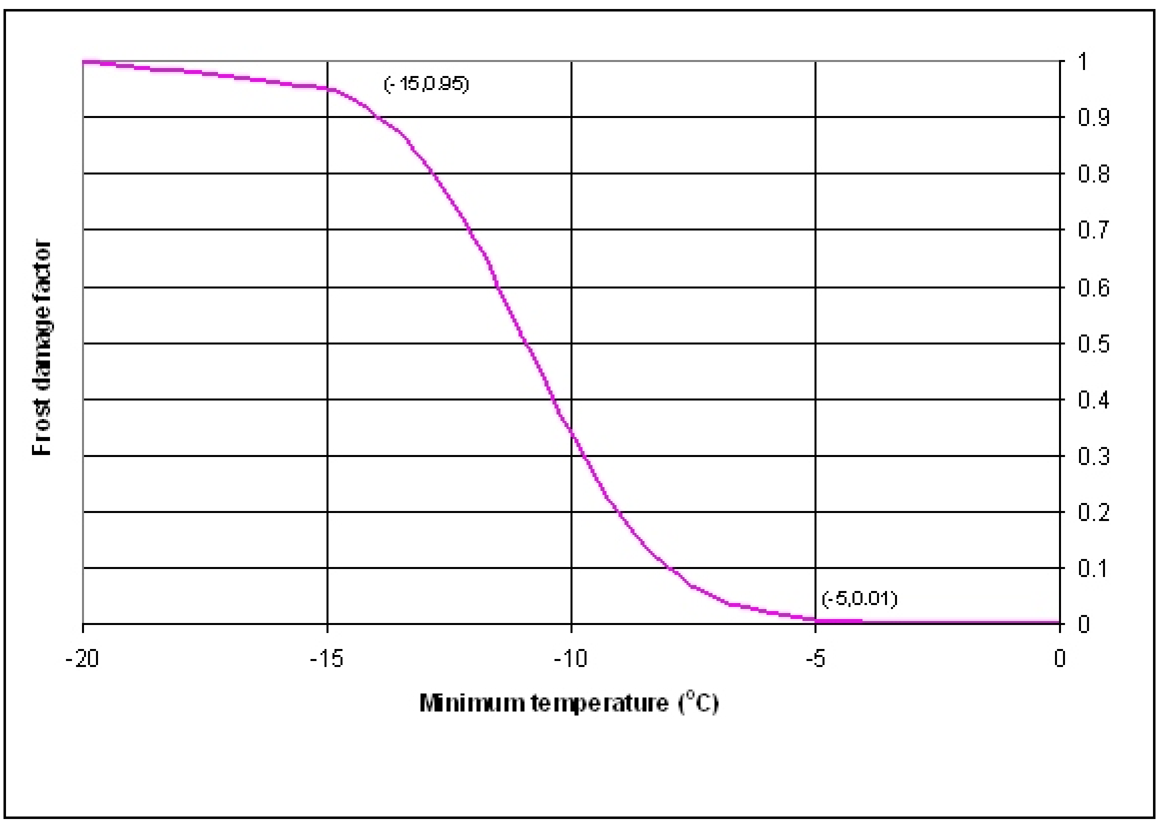


Figure 5.15. Example frost damage curve.

The frost parameters follow:
Upper frost damage threshold temperature: This label should be changed to read 'upper frost damage temperature'.

Lower frost damage threshold temperature: This label should be changed to read 'lower frost damage temperature'.

Damage at upper frost damage threshold temperature: This label should be changed to read 'relative damage at upper frost temperature'

Damage at lower frost damage threshold temperature: This label should be changed to read 'relative damage at lower frost temperature'.

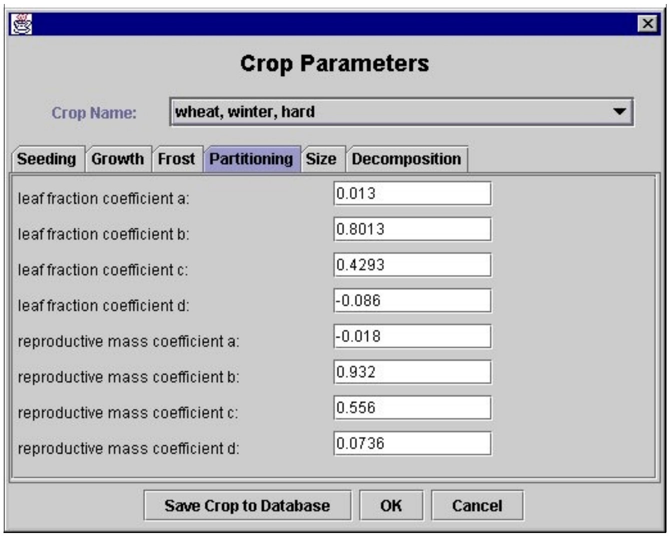


Figure 5.16. Partitioning tab window.

Partitioning tab (Fig 5.16): There 8 parameters in this tab. These parameters are the coefficients in a 4-parameter logistic function to determine partitioning of 'shoot' biomass into leaf or reproductive masses. The first 4 coefficients are for leaf biomass and the last 4 are for reproductive biomass (Fig. 5.17).

Note: Changing parameters on the 'Partitioning' tab is not recommended unless the user completely understands their derivation and the resulting effect of the changes. These parameters require extensive testing and or field data if new values are to be generated and used. Contact WERU for more assistance. The parameters are:

leaf fraction coefficient a: The intercept of a 4-parameter logistic function used in computing the fraction of daily converted 'shoot' (above ground) biomass that goes into leaves.

leaf fraction coefficient b: The asymptote of a 4-parameter logistic function used in computing the fraction of daily converted 'shoot' (above ground) biomass that goes into leaves.

leaf fraction coefficient c: The inflection point of a 4-parameter logistic function used in computing the fraction of daily converted 'shoot' (above ground) biomass that goes into leaves.

leaf fraction coefficient d: The inverse of the slope of a 4-parameter logistic function used in computing the fraction of daily converted 'shoot' (above ground) biomass that goes into leaves.

reproductive mass fraction coefficient a: The intercept of a 4-parameter logistic function used in computing the fraction of daily converted 'shoot' (above ground) biomass that goes into reproductive parts or yield.

reproductive mass fraction coefficient b: The asymptote of a 4-parameter logistic function used in computing the fraction of daily converted 'shoot' (above ground) biomass that goes into reproductive parts or yield.

reproductive mass fraction coefficient c: The inflection point of a 4-parameter logistic function used in computing the fraction of daily converted 'shoot' (above ground) biomass that goes into reproductive parts or yield.

reproductive mass fraction coefficient d: The inverse of the slope of a 4-parameter logistic function used in computing the fraction of daily converted 'shoot' (above ground) biomass that goes into reproductive parts or yield.

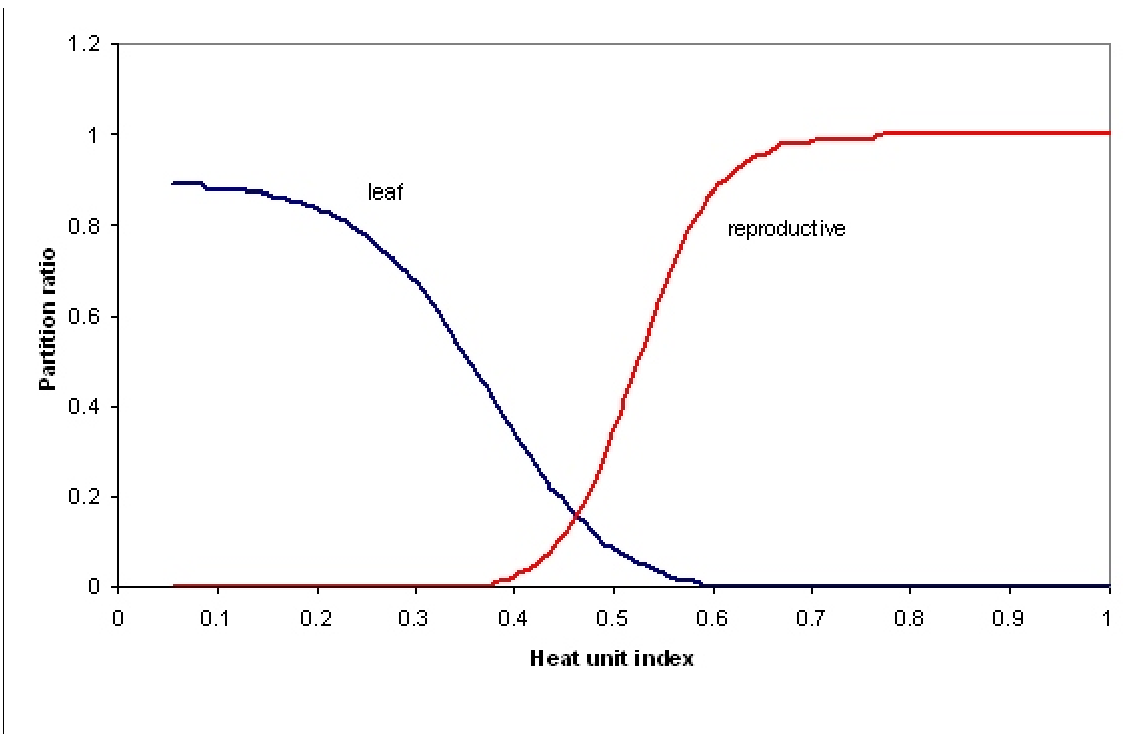


Figure 5.17. Example shoot and reproductive growth curves.

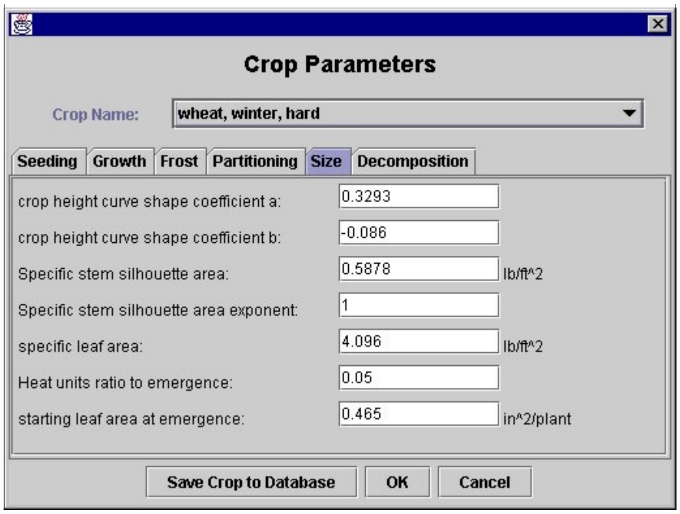


Figure 5.18. Size tab window.

Size tab (Fig 5.18): Miscellaneous types of crop architecture parameters are contained in this tab.

Note: Changing parameters on the 'Size' tab is not recommended unless the user completely understands their derivation and the resulting effect of the changes. These parameters require extensive testing and or field data if new values are to be generated and used. Contact WERU for more assistance.

The parameters are:

crop height curve shape coefficient a: The inflection point of a 2-parameter sigmoid function used to compute plant height.

crop height curve shape coefficient b: The inverse of the slope of a 2-parameter sigmoid function used to compute plant height (Fig. 5.19). These two parameters determine the potential rate of increase in plant height of a crop. The parameters are the result of assuming that plant height growth follows the growth patterns in leaf area. However, these parameters can also be derived from field measured plant height data.

Specific stem silhouette area: A slope coefficient of a power function.

Specific stem silhouette area exponent: For many crops, for which field data are available, it has been found that the relationship of stem silhouette area to its mass is strongly correlated to a 2-parameter power function. The power function is used in the model to compute stem silhouette area. The parameters are the coefficients of the power function. These parameters can be determined from field data of stem mass and stem silhouette area.

specific leaf area: The slope of a linear regression line of leaf mass vs leaf area. A zero-intercept linear function relating leaf mass to leaf area is used in the model to convert leaf mass to leaf area. This parameter can be determined from field data of leaf mass and leaf area.

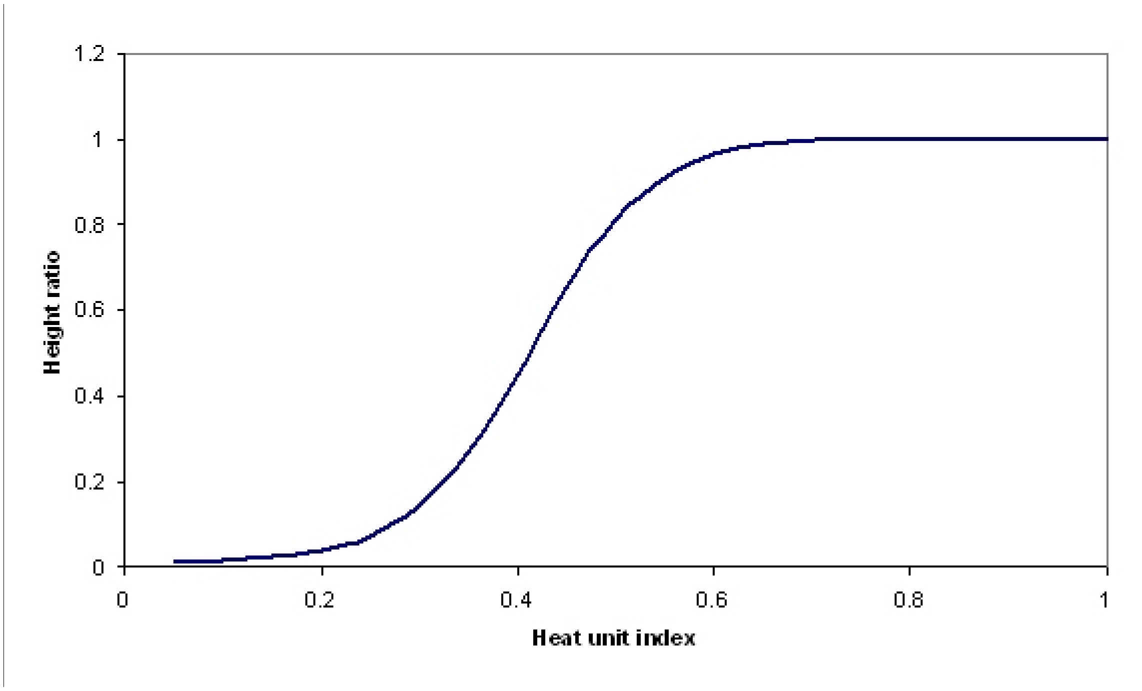


Figure 5.19. Sample graph of the function used to compute plant height.

Heat unit ratio to emergence: The relative heat units required for emergence. The model assumes that under average conditions it takes about 100 degree C days from seeding to emergence. The parameter is the ratio of degree C days from seeding to emergence to the degree C days from seeding to maturity.

starting leaf area per plant at emergence: The average estimated leaf area per plant when seedling emerges from the ground (inches^2/plant).

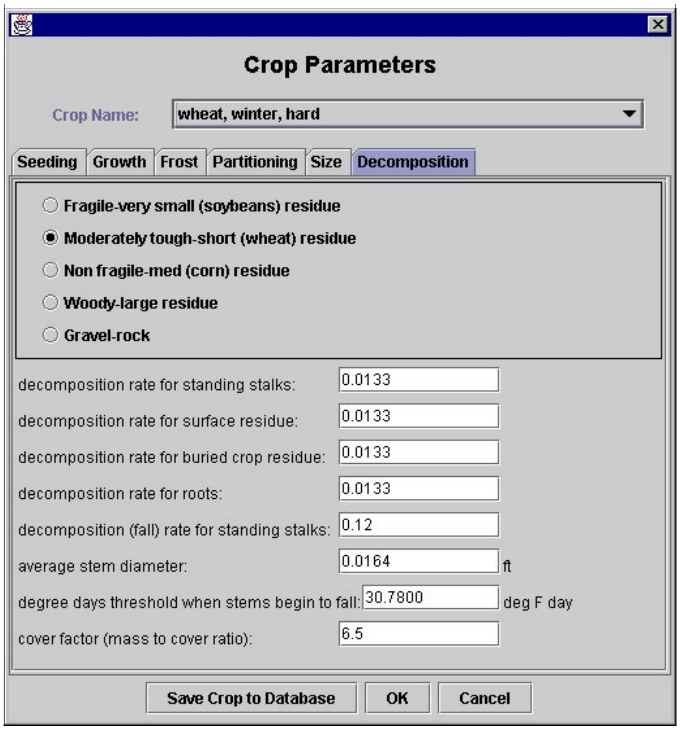


Figure 5.20. Decomposition tab window.

Decomposition tab (Fig 5.20): Five options are available for selecting decomposition parameters for surface and buried residue. They range from fragile to non-erodible types depending on the crop type.

Note: Changing parameters on the 'Decomposition' tab is not recommended unless the user completely understands their derivation and the resulting effect of the changes. These parameters require extensive testing and or field data if new values are to be generated and used. Contact WERU for more assistance.

Parameters for each option are:

decomposition rate for standing stalks: Standing residue mass decomposition rate (g/g/day).

decomposition rate for surface residues: Flat residue decomposition rate (g/g/day).

decomposition rate for buried crop residue: Buried residue decomposition rate (g/g/day).

decomposition rate for roots: Root residue mass decomposition rate (g/g/day).

decomposition (fall) rate for standing stalks: The rate at which standing stalks fall to a flattened (horizontal) position on the soil surface.

average stem diameter: Residue stem diameter (meters or feet).

degree days threshold when stems begin to fall: Threshold degree C days (degree C days).

cover factor (mass to cover ratio): kg m^{-2}

Management Database

Submodel Report Flags and Command Line Options

Submodel Report Flags

To generate various kinds of reports, a flag must be set. To set the option through the interface use the output tab of the Configuration screen. A flag number is entered in the box in the appropriate submodel. A flag of zero, '0', will result in no output generated to the listed file. It should be noted that generating these files may create large file sizes and significantly slow the execution of the WEPS model.

Submodel & flag no.	file name(s)	description
Hydrology		
0		no output generated
1	hydro.out	daily output
2	water.out	hourly output for each day
3	hydro.out & water.out	generates both files
4	temp.out	daily soil temperature output by layer
5	temp.out & hydro.out	generates both files
6	temp.out & water.out	generates both files
7	temp.out & water.out & hydro.out	generates all three files
Soil		
0		no output generated
1	soil.out	daily submodel output
Management		
0		no output generated
1	manage.out	daily submodel output
Crop		
0		no output generated
1	crop.out	daily submodel output
Decomposition		
0		no output generated
1	dabove.out	daily above ground submodel output
2	dbelow.out	daily below ground submodel output
3	dabove.out & dbelow.out	generates both files

Erosion

0		no output generated
1	erosion.out	currently generates an empty file
	eegt.out	currently generates an empty file
	eros.tmp	currently generates an empty file
	subday.out	daily wind direction and subdaily (i.e., hourly) wind speeds

A flag of one, '1', for any submodel generates the file 'plot.out' which contains a variety of output variables on a daily basis. This file is suitable for input into spreadsheets or plotting packages for plotting of daily data. See the header of the file or contact the WEPS developers for more information on the variables output to 'plot.out.

Command Line Options

Windgen 4

Usage: wind_gen4 -D -V -v -h -l -f dbfile -o outfile -s # -x # -r # -b # -y #-u # -d # -?

-D	debug flag
-V	display version and exit
-v	set the verbose option
-h	do not display output title heading
-l	display long (additional) output
-f dbfile	specify wind database file (wind_gen.wdb)
-o outfile	specify output file (stdout)
-s #	specify station WBAN no.
-x #	specify station database index no.
-r #	specify random number seed (54321)
-b #	specify beginning simulation (calendar) year (1)
-y #	specify number of years to simulate (1)
-u #	specify storm duration length in hours (6)
-d #	specify number of days to build storms from (5)

Wind station WBAN code number required Note that only the "-f" option with the location of the appropriate wind_gen database file to access is required for WEPS 1.0. All other options are either automatically added internally by WEPS 1.0 or are optional. Those that WEPS 1.0 automatically sets are:

-s #
-y #
-o outfile

Those that can be added to the command line and should work within WEPS 1.0 are (NOTE that I haven't verified them - lew):

-D
-v
-x #
-r #
-b #
-u #
-d #

Those that can't be specified when wind_gen4 is run within WEPS 1.0 are:

-V
-l
-h
-?

<u>Cligen Version 5.2254</u>
CLIGEN V-5.2254 - Climate Generator w/ QC-SNDG
Usage: cligen -S -s -I -o -b -y -f -F -H -r -t -I# -v -V-? -O

-S<state number>
-s<station ID number>
-i<input file name>
-o<output file name>
-b<beginning year>
-y<duration in years>
-f old WEPS record format
-F overwrite output file if it exists
-H omit header output
-r<random seed>
-t<Sim Type (WEPP: 4=SglStm, 5=Contin)>
-I0 no interpolation (default)
-I1 linear interpolation
-I2 Fourier interpolation
-I3 interpolation to preserve avgs
-v
-V verbose
-h, -?, -\\?, /h help
-O<option 6 – observed data filename>

Make sure there are no spaces between each flag and its parameter. If command line options are omitted, CLIGEN will interactively request the required information.

Note that the "-I" option with the location of the appropriate cligen database file to access, the "-b" option specifying the start year (usually 1), "-t" option with value "5", and the "-F" option are all required for WEPS 1.0. All other options are either automatically added internally by WEPS 1.0, are optional, or not applicable when used with WEPS 1.0.

Those that WEPS 1.0 automatically sets are:

- -S#
- -s#
- -y#
- -ooutfile

Those that can be added to the command line and should work within WEPS 1.0 are (NOTE that I haven't verified them - lew):

- -r#
- -I0
- -I1
- -I2
- -I3
- -V

Those that can't be specified when cligen5110 is run within WEPS 1.0 are:

- -v
- -h
- -?
- -t# (with options values other than 5)

WEPS 1.0

Usage: weps -? -I# -S# -s# -P -R# -E -e

Valid command line options:

-? -h Display this help screen

-I# Specify if initialization is done and if so, the # loops

0 = No initialization

1 = Runs one management cycle (default)

2 = Runs x management cycles

-S# Vary type of value input for 1/3 bar, 15 bar water

0 = 1/3bar(vol) 15bar(vol)

1 = 1/3bar(vol) 15bar(grav)

2 = 1/3bar(grav) 15bar(grav)
3 = use texture based calculation (default)
Override 1/3bar, 15bar, bulk density w/ texture estimate

-s# Specify soil ifc file input format type
0 = new format (additional parameters)
1 = old format (default)

-P Specify path for project run directory
Must be specified if other command line switches are used. Specifying only the path without the "-P" option only works when no other command line switches are specified (e.g., weps path_to_weps.run).

-R# Erosion summary report debug screen dump
0 = no report debugs to screen (default)
1 = 1st level debug messages sent to screen
2 = 1st and 2nd level debug messages sent to screen
3 = 1st, 2nd, and 3rd level debug messages sent to screen

-O Generate stand alone erosion input file on simulation day
Specify -O2932 to output file on simulation day 2932

-o Generate stand alone erosion input file on DD/MM/YY
Specify -o020901 to output file on day 2 month 9 year 1
Day and month must be 2 digits, Year can be 1 to 4 digits

-E Simulate "erosion" in WEPS run
0 = Do not run the erosion submodel
1 = Run the erosion submodel (default)

-C WEPS crop calibration mode
0 = Do not run crop calibration (default)
1 = Run crop calibration.

-Y Optional functional yield/residue ratio
0 = Use full staged biomass partitioning
1 = Use functional yield/residue ratio (default)

Default options are set to:
-I1 -S3 -s1 -R0 -Oo(no file) -E1 -C0 -Y1 -P./

Note that only the "-P" option is required for WEPS 1.0. (It must be the last option specified if more than one option is listed because WEPS 1.0 appends the current WEPS Project Run directory path prior to executing the WEPS science model.

The options that the WEPS 1.0 interface set automatically are:
-Ppath
WEPS 1.0 assumes that the user has specified the "-P" (as the last option) within the WEPS 1.0 configuration panel without the "path". WEPS 1.0 appends the path of the current WEPS Project Run directory prior to executing the WEPS science model.

Those that can be added to the command line and should work within WEPS 1.0 are (NOTE that I haven't verified them - lew):

-I#
-S#
-s#
-R#
-O
-o
-E#
-C#
-Y#

Those that can't be specified when run within the WEPS 1.0 interface are:

-h
-?

Using WEPS with Measured Data

Introduction

The Wind Erosion Prediction System (WEPS) is designed to simulate soil loss by wind from cultivated fields by simulating weather and field conditions (Wagner, 1997). However, in some situations, WEPS may be run using measured or simulated data from other models. This is typically done to validate various components or submodels of WEPS, particularly the erosion portion of the model. For example, a user may have measured soil loss data and limited weather and soil data. This user can input the measured weather and soil data to compare the model soil loss with the measured loss. This section will explore the use of WEPS with measured or other simulated data.

WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, and erosion by wind. It has the capability of simulating spatial and temporal variability of a field's soil, crop, and residue conditions and soil loss/deposition within a field. The saltation/creep, suspension, and PM10 components of eroding material are also reported separately by direction. The WEPS model is modular in design with submodels that simulate weather, soil conditions, crop growth, residue decomposition, management operations, and soil loss by wind. It is designed to be used by the USDA-NRCS, under a wide range of conditions throughout the U.S. However, with proper inputs, WEPS is easily adapted to other parts of the world.

In typical applications, input files are created within the user interface which supplies these files to the science portion of the model to calculate field conditions and erosion. WEPS requires the following input files for a simulation run; a 'Run file', Windgen file', 'Cligen file', 'Soil file', and a 'Management file'. These files can be modified with measured or other data and run with WEPS under certain constraints. All input files except the Management file, may be easily altered using a standard text editor or the WEPS user interface to reflect measured data. All input files must be formatted to meet the requirements for WEPS. A description of these input files and considerations for their creation with measured data are given below.

It is important to note that the purpose of the WEPS model is to simulate changes in field conditions as a result of management and weather to estimate wind erosion. To simulate these changes in field conditions, WEPS is intended for simulations of multiple day periods of time. If one desires to simulate only a single storm, field conditions are essentially static and the full WEPS model is not necessary. To simulate single erosion events of one day or less, the standalone erosion submodel is recommended. The use of the standalone submodel is also described below.

WEPS can be run from either the interface or the command line. Typically, users will run the model through the interface where modified input files can be selected. See the individual input file descriptions below for information on how to select modified files within the interface. Some input files are best modified within the interface (e.g., soil and management files) while others require some sort of separate editing or creation with a separate program (e.g., weather files). Files that are modified by the user but input via the interface must be placed in the appropriate project directory (i.e., folder). Those wishing to run WEPS via the command are advised to see the section titled "Report Flags and Command Line Options" in the WEPS User Manual.

Output files obtained from WEPS are described elsewhere in the WEPS User Manual. For assistance using measured data with WEPS, please go to {http://www.weru.ksu.edu/weps}.

Run File

The default file name of the WEPS run file is 'weps.run'. This file contains general information for a simulation run including the dates of the simulation, the field and barrier dimensions, the field location, and the path and names of the other input files (described below). The 'run file' parameters can be modified to match the parameters for the field simulated. The list of the other input files should specify the path and name of measured data to be used. This file contains comments (indicated by a '#' in column one) which describes each line of input data to aid in checking and modifying input data.

Below is a description of the items required in the Run File of WEPS. An example Run File is shown in Figure 5.21. Note that lines beginning with '#' character are comment lines. Lines beginning with '# RFD' are comments used by the interface. Some of the parameters are critical to the science model (SC), some are critical to the operation of the interface (IC), some are critical to both (SC+IC), while others are not critical to either (NC). An example of non-critical parameters would include the User Name which does not affect the operation of WEPS and is used for informational purposes only. In all cases however, some sort of 'placeholder' is required, even for non-critical parameters. In other words, blank lines are not allowed and each expected line should be present and filled with some characters.

The interface is a simple way to input data into the Run file and is recommended. The information below is presented for the benefit of those users who wish to modify the input file themselves.

Run File Parameters:

--USER INFORMATION
UserName - This character variable holds the user name. (NC)

FieldNo - This character variable is a part of a field tract that is separated by permanent boundaries. (NC) Note that FieldNo, TractNo, FarmNo, RunMode, RunCycle, and RotCycle are all entered on one line with each parameter separated by the pipe "|" symbol.

TractNo - This character variable is often used by FSA and NRCS to identify a field. (NC)

FarmNo - This character variable is a farm identification number. (NC)

RunMode - This character variable specifies the type of run length as either the NRCS method (specifies a fixed number of cycles), use simulation run start and end dates on the main screen, or specify the use of management rotation cycles on the main screen. (IC)

RunCycle - This variable specifies the number of management rotation cycles to simulate in a WEPS run. (IC)

RotCycle - This character variable specifies the number of years in the rotation cycle. (IC)

SiteCounty and SiteState - This character variable specifies the county and state to be simulated. (NC)

--SITE INFORMATION
LatitudeSign - This parameter is used to specify the specify the hemisphere of the latitude. Enter a plus sign (+) for the Northern hemisphere and a minus sign (-) for the Southern hemisphere. (IC)

Latitude -The latitude of the location modeled in degrees and fraction of degrees. The CLIGEN and WINDGEN stations nearest to the center of the location county will then be determined by the interface and listed. Latitude is also used by the science model to determine day length and time of sunrise. (SC+IC)

LongitudeSign - This parameter is used to specify the specify the hemisphere of the longitude. Enter a plus sign (+) for the Eastern hemisphere and a minus sign (-) for the Western hemisphere. (IC)

Longitude -The longitude of the location modeled in degrees and fraction of degrees. The CLIGEN and WINDGEN stations nearest to the center of the location county will be determined by the interface. Longitude is used by the science model to determine day length as well as time of sunrise. (SC+IC)

Elevation (meters) - The average elevation for the location to be modeled in the units of measure displayed on the screen (feet or meters). The science model requires elevation in meters and converts feet to meters. (SC+IC)

CliGenStationID - The name of the CLIGEN station used to generate many of the weather parameters for WEPS. (IC)

WindGenStationID - The name of WINDGEN station used to generate the wind parameters for WEPS. (IC)

--*SIMULATION PERIOD*
StartDate (day, month, year) - The "Start Date" is the date from which you want the simulation to begin. The format is the numerical value for day, month (e.g., 03 for March), and year (two or four characters), each separated by a blank space. (SC+IC)

> A typical run begins on January 1 and ends on December 31 with multiple years of simulation. However, for those using WEPS with historical data, other start and ending days and months may be entered. The correctness of output has not been tested in these situations.

EndDate (day, month, year) - The "End Date" is the date on which you want the simulation to end. The format is the numerical value for day, month (e.g., 03 for March), and year (two or four characters), each separated by a blank space. (SC+IC)

> A typical run begins on January 1 and ends on December 31 with multiple years of simulation. However, for those using WEPS with historical data, other start and ending days and months may be entered. The correctness of output has not been tested in these situations.

TimeSteps (per day) - The number of time steps per day used for the daily distribution of simulated wind speed for erosion calculations. If none is entered through the interface Configuration Screen, the number of time steps is assumed to be 24. (SC)

--*RUN FILE NAMES (INPUT)*
climate file - This character variable holds the path and CLIGEN input file name. (SC+IC)

wind file - This character variable holds the path and WINDGEN input file name. (SC+IC)

soil file - This character variable holds the path and soil input file name. (SC+IC) management file - This character variable holds the path and management input file name. (SC+IC)

--WEPS OUTPUT OPTIONS

OutputFile - This character variable holds the path and general output file name. (SC+IC)

ReportForm - This variable was intended to hold six (6) flags for selecting various general report forms but is not used in the current version of WEPS. (NC)

OutputPeriod - This variable was intended to hold a flag for selecting the period of output but is not used in the current version of WEPS. (NC)

SubmodelOutput - This variable holds numerical flags to print detailed reports for various submodels. Submodel detail report flags are described elsewhere in the WEPS User Manual. (SC+IC)

DebugOutput - This variable holds numerical flags to print debug reports for various submodels. Submodel debug report flags are described elsewhere in the WEPS User Manual. (SC+IC)

--SIMULATION REGION INFORMATION

RegionAngle (degrees from North) - This is the angle of the field with respect to North. (SC enter angle 0-360 decrees, clockwise from North) or (IC enter angle up to +/- 45 degrees)

SimCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the simulation region. This is typically the lower left corner for the North-South oriented rectangular simulation region. (SC+IC)

SimCoords2 (meters) - These two variables hold the X and Y coordinates of the opposite corner of the simulation region (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular simulation regions. (SC+IC)

ScaleFactors - These two variables were intended to hold scale factors for displaying the simulation region in the interface but is not used in the current version of WEPS. (NC)

AcctRegNo - This variable holds the number of accounting regions in the simulation region. If more than one accounting region is present (i.e., AcctRegNo > 1), then the accounting region coordinates are repeated in succession to account for each accounting region. (SC+IC)

AcctCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the accounting region. This is typically the lower left corner for the North-South oriented rectangular accounting region. (SC+IC)

AcctCoords2 (meters)- These two variables hold the X and Y coordinates of the opposite corner of the accounting region (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular accounting regions. (SC+IC)

SubRegNo - This variable holds the number of subregions in the simulation region. If more than one accounting region is present (i.e., SubRegNo > 1), then the subregion coordinates are repeated in succession to account for each subregion. (SC+IC)

SubCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the current subregion. This is typically the lower left corner for the North-South oriented rectangular subregion. (SC+IC)

SubCoords2 (meters) - These two variables hold the X and Y coordinates of the opposite corner of the subregion (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular subregions. (SC+IC)

AverageSlope (%) - The average slope of the subregion. This information is now obtained from the soil input file. (NC)

-- *BARRIERS*
NumberBar - This variable holds the number of barriers in the simulation region. If more than one barrier is present (i.e., NumberBar > 1), then the barrier information (i.e., barrier coordinates and parameters) are repeated in succession to account for each barrier. (SC+IC)

BarrierCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the barrier. This is typically the lower left corner of the barrier. (SC+IC)

BarrierCoords2 (meters) -These two variables hold the X and Y coordinates of the opposite corner of the barrier (furthest from the origin). This is typically the upper right corner of the barrier. (SC+IC)

BarrierType - This character variable specifies the name of the type of barrier. (NC)

BarrierHeight (meters) - This parameter is the barrier average height. (SC+IC)

BarrierWidth (meters) - This parameter is the barrier average width (not length). (SC+IC)

BarrierPorosity (%) - The barrier porosity is expressed as an optical porosity. It is the open space as viewed looking perpendicular through the barrier expressed as a percent of the total area (ie., ((1.0 - silhouette area) x 100).

Figure 5.21. Example Run file.

```
#------------ WEPS SIMULATION RUN FILE ------------
# Note: Lines beginning with '#' are comment lines.
#       Lines beginning with '#   RFD' are comments used by the interface.
#
# --USER INFORMATION
#   RFD-UserName
Dustin Fields
#   RFD-FieldNo RFD-TractNo RFD-FarmNo RFD-RunMode RFD-RunCycle RFD-RotCycle
789 | 456 | 123 | cycle | 2 | 2
#   RFD-SiteCounty and SiteState
Finney, Kansas
#
# --SITE INFORMATION
#   RFD-LatitudeSign RFD-Latitude
+38.00
#   RFD-LongitudeSign RFD-Longitude
-100.66
#   RFD-Elevation (meters)
801
#   RFD-CliGenStationID
CIMARRON
#   RFD-WindGenStationID
GARDEN CITY MUNI
#
# --SIMULATION PERIOD
#   RFD-StartDate (day_month_year)
01 01 01
#   RFD-EndDate (day_month_year)
31 12 4
#   RFD-TimeSteps (per_day)
24
#
# --RUN FILE NAMES (INPUT)
#   RFD-climate file
cli_gen.cli
#   RFD-wind file
win_gen.win
#   RFD-sub-daily file
none
#   RFD-SoilFile
Otero_101OF_100_FSL.ifc
#   RFD-ManageFile
KS_wheat_fallow.man
#
# --WEPS OUTPUT OPTIONS
#   RFD-OutputFile
output.tmp
#   RFD-ReportForm
0 0 0 0 0 0
#   RFD-OutputPeriod
2
#   RFD-SubmodelOutput
0 0 0 0 0 0
#   RFD-DebugOutput
0 0 0 0 0
#
# --SIMULATION REGION INFORMATION
#   RFD-RegionAngle (deg_clockwise_north)
21
```

```
#   RFD-SimCoords1 (meters)
0.0  0.0
#   RFD-SimCoords2 (meters)
1500.2  1500
#   RFD-ScaleFactors (place holder - needed for older versions of WEPS)
5.5 5.5
#
#   RFD-AcctRegNo
1
#   RFD-AcctCoords1 (meters)
    0.0  0.0
#   RFD-AcctCoords2 (meters)
1500.2  1500
#
#   RFD-SubregionNo
1
#   RFD-SubCoords1 (meters)
0.0  0.0
#   RFD-SubCoords2 (meters)
1500.2  1500
#   RFD-AverageSlope (%)
0.50
#  --BARRIERS
#   RFD-NumberBar
2
#   RFD-BarrierCoord1 (meters)
-1 0
#   RFD-BarrierCoords2 (meters)
0 1500
#   RFD-BarrierType
Snow fence
#   RFD-BarrierHeight (meters)
1.2
#   RFD-BarrierWidth (meters)
1
#   RFD-BarrierPorosity (%)
0.6
#   RFD-BarrierCoord (meters)
0 -2
1500.2 0
#   RFD-BarrierType
Sorghum(2 row)
#   RFD-BarrierHeight (meters)
2
#   RFD-BarrierWidth (meters)
2
#   RFD-BarrierPorosity (%)
0.5
#
#---------- END OF SIMULATION RUN FILE ------------
```

Weather Files

WEPS runs are made for multiple years in full year increments beginning on January 1. If only a partial year of weather data is available (typical), the user has two options. One is to substitute measured data within the simulated weather file and observe the output for the period with measured data. The other option is to use the stand alone Erosion model (described below) for single day simulations. Two weather files are required by the full WEPS model, a Windgen file and a Cligen file.

If alternative weather files are input through the interface they can be selected by first checking the appropriate wind or climate box on the “Run” tab of the “Configuration” window. Then enter the file name and path or choose the file by clicking the folder icon on the “Location Information”panel of the main screen..

Windgen File

The default Windgen file extension is “win” (e.g., windgen.win). This file contains both the wind speed (m s^{-1}) on a subdaily time step and one wind direction (degrees clockwise from North) for each day of the simulation. The subdaily wind speeds are by default the average hourly speeds (i.e., 24, 1 hourly averages) but can be of other time steps of equal length (e.g., 96, 15 minute averages or 8, 3 hour averages) if specified in the weps.run file. WEPS ignores the file header information which is in the first seven rows. Below is a description of the lines and columns required by WEPS as well as an example Windgen file (Figure 5.22).

Windgen File Parameters:

Lines 1 - 7:	Comment lines. These do not need to be filled out but WEPS does need to have these seven lined present with a ‘#’ in column one.
Line 8 +:	daily weather data
Columns 1, 2, 3:	**day mo year** - the day, month, and year of simulation (integer).
Column 3:	**dir** - wind direction for the day. WEPS assumes that the direction is constant for the day (real- degrees clockwise with North = 0.0).
Columns 4 - end:	**hr1 hr2 . . .** - average hourly wind speeds, distributed throughout the entire day. These represent by default, twenty-four hourly average wind speeds (real-meters/second). If other time steps are used they should be of equal length and the number of these periods specified in the weps.run file.

Figure 5.22. Example WINDGEN file.

```
#    WIND_GEN3  $Revision: 1.12 $ Hourly values per day output
# station: 13985 DODGE_CITY, KS  USA
# lat:  37deg  46min N  lon:  99deg  58min W
# period: 19610421-19781231  el: 796m
# day mo year dir   hr1   hr2   hr3   hr4   hr5   hr6   hr7   hr8   hr9  .  .  .
#             deg   m/s   m/s   m/s   m/s   m/s   m/s   m/s   m/s   m/s  .  .  .
#
--------------------------------------------------------------------------------
  1  1    1   0.0   3.7   4.7   6.1   6.4   6.9   7.7   8.3   9.3  14.4  .  .  .
  2  1    1 180.0   3.5   4.7   5.5   5.8   6.4   6.9   7.5   7.9   8.5  .  .  .
  3  1    1   0.0   3.7   4.7   6.1   6.4   6.8   7.7   8.1   9.3  12.1  .  .  .
  4  1    1 157.5   2.9   3.5   4.1   4.3   4.6   5.0   5.4   5.6   7.4  .  .  .
  5  1    1 135.0   2.3   2.9   3.5   3.8   4.5   4.8   5.4   6.0   8.2  .  .  .
  6  1    1  22.5   3.5   4.6   5.2   5.8   6.6   7.2   7.9   8.8  11.0  .  .  .
  7  1    1 180.0   3.8   4.9   5.6   5.8   6.5   7.1   7.7   8.0   9.4  .  .  .
  8  1    1 202.5   4.0   4.8   5.2   5.7   5.9   6.2   6.7   7.2   8.1  .  .  .
  9  1    1  22.5   3.5   4.6   5.1   5.8   6.4   7.1   7.7   8.8  10.3  .  .  .
 10  1    1 135.0   2.1   2.8   3.4   3.8   4.4   4.7   5.3   5.8   6.7  .  .  .
 11  1    1 202.5   4.2   5.0   5.3   5.7   5.9   6.4   6.9   7.4   9.5  .  .  .
 12  1    1 337.5   3.1   3.6   4.4   4.9   5.5   6.5   7.1   8.0   9.0  .  .  .
 13  1    1 270.0   3.0   3.3   3.8   4.2   4.6   4.8   5.0   5.5   6.3  .  . .
 14  1    1   0.0   3.6   4.4   5.7   6.3   6.6   7.2   7.9   9.0  10.1  .  .  .
 15  1    1   0.0   3.7   4.5   6.1   6.3   6.7   7.7   8.0   9.1  11.3  .  .  .
 16  1    1 157.5   2.5   3.4   3.9   4.3   4.5   4.9   5.2   5.6   6.1  .  .  .
 17  1    1 292.5   3.4   4.0   4.3   4.6   5.2   5.4   5.8   6.2   7.2  .  .  .
 18  1    1  22.5   3.3   4.5   5.0   5.6   6.2   7.0   7.7   8.5   9.0  .  .  .
 19  1    1 157.5   3.0   3.6   4.1   4.4   4.7   5.1   5.4   5.7   8.2  .  .  .
 20  1    1 180.0   3.8   4.8   5.6   5.8   6.4   7.0   7.7   8.0   8.9  .  .  .
 21  1    1   0.0   3.7   4.4   6.0   6.3   6.7   7.5   8.0   9.1  10.5  .  .  .
 22  1    1  22.5   3.5   4.7   5.2   5.8   6.6   7.3   8.0   8.9  11.7  .  .  .
 23  1    1 270.0   3.1   3.4   3.9   4.2   4.6   4.8   5.0   5.5   6.5  .  .  .
 24  1    1 135.0   2.0   2.8   3.4   3.7   4.2   4.7   5.3   5.8   6.5  .  .  .
 25  1    1 157.5   2.7   3.5   4.0   4.3   4.5   5.0   5.2   5.6   6.9  .  .  .
 26  1    1  22.5   3.4   4.6   5.1   5.7   6.2   7.1   7.7   8.6   9.7  .  .  .
 27  1    1 180.0   3.8   4.9   5.6   6.0   6.6   7.1   7.7   8.0  10.0  .  .  .
 28  1    1 315.0   2.8   3.5   4.1   4.5   4.9   5.5   6.1   6.4   7.1  .  .  .
 29  1    1 202.5   4.0   4.9   5.2   5.7   5.9   6.2   6.7   7.2   8.4  .  .  .
 30  1    1 247.5   2.6   3.1   3.6   4.2   4.5   4.9   5.2   5.6   6.7  .  .  .
 31  1    1   0.0   3.7   4.4   5.9   6.5   7.4   8.2   9.2  10.1  12.2  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
```

Cligen File

The default Cligen file extension is "cli" (e.g., cligen.cli). The Cligen weather generator was developed for use with the Water Erosion Prediction Project (WEPP) (Flanagan, et.al., 2001) and is used by WEPS to simulate other weather parameters. The input file created by Cligen includes precipitation amount (mm), duration (hr), time to peak (fraction of duration), and peak intensity (mm hr^{-1}) as well as maximum and minimum air temperature (°C), solar radiation (ly d^{-1}), and dew point temperature (°C). This file also contains historical monthly averages for maximum and minimum temperature (°C) which are required by WEPS.

Although WEPS ignores non-needed data in the Cligen file, WEPS reads the entire file so each line and column in WEPS must be populated even though some elements may be 'dummy' variables not used by WEPS. For example, line 2 contains information not used by WEPS but must be present with any characters present. The Cligen file is read in free format. Below is a description of the lines and columns WEPS requires as well as an example Cligen file (Figure 5.23).

Cligen File Parmeters:

Line 1: Cligen version number. Must be "5.110" for the file format described in this document.

Lines 2-6: Information in these lines are not required by WEPS but must be present as place holders.

Line 7: Observed monthly ave maximum temperatures (°C).

Line 8 Comment line.

Line 9: Observed monthly ave minimum temperatures ©).

Lines 10-15: Comment lines.

Line 16 +: daily weather data.

Columns 1, 2, 3: **day mon year** - the day, month, and year of simulation (integer).

Column 4: **prcp** - total precipitation for the day including snow, hail and rain (real- milimeters).

Column 5: **dur** - duration f the rainfall event (real- hours).

Column 6: **tp** - fraction of time to peak (real- time to peak in hours/duration in hours).

Column 7: **ip** - WEPP data, ignored in WEPS but must have some numbers present (e.g., 0.0)(real).

Columns 8, 9: **tmax tmin** - the maximum and minimum daily air temperature (real - C).

Column 10: **rad** - daily solar radiation (real - ly/day).

Columns 11-12: WEPP wind data, ignored in WEPS but numbers must be present (e.g., 0.0) (real).

Column 13: **dew** - dew point temperature (real - C).

Figure 5.23. Example Cligen File.

```
5.110
  1   0   0
  Station:  CIMARRON KS                                   CLIGEN VERSION 5.110 -r:    0 -I: 0
Latitude Longitude Elevation(m) Obs. Years  Beginning year  Years simulated Command Line:
   37.80  -100.35      801        54           1              6        -S14 -s1522 -idb\cligen_fs.db -b1
Observed monthly ave max temperature ©)
  6.9  10.1  14.5  20.8  25.3  31.1  34.2  33.2  28.8  22.8  13.8   8.3
Observed monthly ave min temperature ©)
 -8.1  -5.8  -2.1   4.1   9.8  15.3  18.0  17.0  12.2   5.3  -2.4  -6.7
Observed monthly ave solar radiation (Langleys/day)
253.0 317.0 420.0 525.0 564.0 643.0 635.0 578.0 491.0 374.0 307.0 234.0
Observed monthly ave precipitation (mm)
 14.3  17.0  33.6  48.3  90.9  89.8  87.2  68.4  45.1  37.0  21.5  13.4
da mo year  prcp  dur   tp     ip  tmax  tmin  rad  w-vl w-dir  tdew
            (mm)  (h)               ©)   ©) (l/d) (m/s)(Deg)   ©)
 1  1    1   0.0  0.00 0.00   0.00   3.9  -2.6 250.  5.5   75.  -0.4
 2  1    1   0.0  0.00 0.00   0.00  -2.5  -5.5 143.  6.0  297.  -6.8
 3  1    1   0.0  0.00 0.00   0.00   0.3  -4.0 219.  8.2  238. -16.9
 4  1    1   0.0  0.00 0.00   0.00  17.8 -10.2 253.  4.0  227. -16.5
 5  1    1   0.0  0.00 0.00   0.00   6.3 -12.3 254.  5.9  314.  -4.9
 6  1    1   0.0  0.00 0.00   0.00  15.3  -3.6 148.  8.3  238.  -4.0
 7  1    1   0.0  0.00 0.00   0.00   0.5 -10.2 257.  7.0   23.  -9.4
 8  1    1   0.4  1.66 0.01   1.01  13.9 -14.2 258.  7.9  355.  -8.5
 9  1    1   0.0  0.00 0.00   0.00   7.1  -5.6 230.  2.6  328.  -6.5
10  1    1   0.0  0.00 0.00   0.00  10.1  -6.2 283.  8.6   49.  -4.8
11  1    1   0.0  0.00 0.00   0.00  10.0  -9.0 263.  0.0    7. -20.9
12  1    1   0.0  0.00 0.00   0.00   2.8 -12.2 231.  6.9  222.  -4.8
13  1    1   0.0  0.00 0.00   0.00  -0.3 -14.1 267.  1.2  317.  -7.3
14  1    1   0.0  0.00 0.00   0.00  -4.0  -6.7 173.  3.4  313. -12.1
15  1    1   0.0  0.00 0.00   0.00  -1.7 -14.8 270.  2.7  132. -18.0
16  1    1   2.3  1.29 0.04   1.01   0.6  -4.9 262.  9.9   15. -13.7
17  1    1   0.0  0.00 0.00   0.00   6.0  -5.0 241.  7.0  338. -12.3
18  1    1   0.0  0.00 0.00   0.00   7.8  -9.1 203.  4.2  262. -13.5
19  1    1   0.0  0.00 0.00   0.00  12.3 -10.5 181.  3.7  275.  -8.1
20  1    1   0.0  0.00 0.00   0.00  -8.9 -10.5 266.  6.0    6. -17.9
21  1    1   0.0  0.00 0.00   0.00  14.7  -9.8 283.  5.7  264.  -3.7
22  1    1   0.0  0.00 0.00   0.00   3.9  -8.0 132.  3.5  233.  -8.2
23  1    1   0.0  0.00 0.00   0.00  11.2 -10.0 196.  4.9  150.  -6.5
24  1    1   0.0  0.00 0.00   0.00   2.3 -15.9 230.  4.6  136. -19.5
25  1    1   0.0  0.00 0.00   0.00  12.6 -13.7 172.  6.2  312.  -0.7
26  1    1   0.0  0.00 0.00   0.00  14.4  -6.0 272.  7.5  156.   4.0
27  1    1   0.0  0.00 0.00   0.00   2.6   0.9 213.  5.7  176.  -5.1
28  1    1   4.2  1.19 0.00   1.01  15.2 -15.3 173.  7.7  170. -14.8
29  1    1  10.6  1.73 0.05   1.01  24.8  -3.5 302.  4.8  206.  -7.3
30  1    1   3.5  1.92 0.29   4.81   8.3  -5.9 280.  2.7  277. -14.0
31  1    1   0.0  0.00 0.00   0.00  20.9   2.3 228.  2.9  240.   1.3
 1  2    1   0.0  0.00 0.00   0.00   7.5  -4.9 241.  7.3  316.  -5.8
 2  2    1   0.0  0.00 0.00   0.00   7.6  -4.6 316.  2.2  169. -10.1
 3  2    1   0.0  0.00 0.00   0.00   3.6 -12.8 326.  4.3  322.  -4.7
 4  2    1   0.0  0.00 0.00   0.00  13.0   1.1 307.  5.1  146. -18.0
 .  .    .    .    .    .      .     .     .    .    .     .     .
 .  .    .    .    .    .      .     .     .    .    .     .     .
```

Soil File
The default soil file name has an "ifc" extension (e.g., amarillo.ifc). This file contains the initial soil conditions at the start of a simulation run. The soil and management submodels then simulate the changes in these conditions as affected by weather, management, and erosion for each simulation day. Even intrinsic parameters such as particle size distribution will change with tillage as layers are mixed. If simulated soil parameters vary significantly from measured values, it is recommended that the user use the stand alone Erosion model (described below). The soil input file includes the taxonomic order, number and thickness (mm) of soil layers, detailed particle size distribution (fraction), wet and dry bulk density ($Mg\ m^{-3}$), aggregate stability ($\ln(J\ m^{-2})$), density ($Mg\ m^{-3}$), and size distribution (fraction), soil crust properties (varies), random and oriented (ridge) roughness (mm), soil water characterization parameters (varies), dry albedo (fraction), organic matter (fraction), pH, calcium carbonate (fraction), and cation exchange capacity ($meq\ 100g^{-1}$). This file also contains comments (indicated by a '#' in column one) which describes each line of input data to aid in checking and modifying input data. Below is a description of the items required by WEPS which can be viewed and edited within soil panel of the WEPS interface. The absolute range is that allowable by WEPS. The typical range lists the range of values to be expected with typical soils. An example Soil file is shown in Figure 5.24.

The soil interface is a simple way to edit input data in the Soil file and is recommended. It is also recommended that the user select an existing soil file from the database with similar properties to the desired soil and modify its properties. Existing soil database files are accessed through the "Template" icon and the soil interface is accessed by clicking the "Soil" button at the bottom of the main screen. The information below is presented for the benefit of those users who wish to modify the input file themselves.

Soil File Parameters:

Soil Identification
State - The state in which the soil occurs (character). The state is not critical to the operation of WEPS and is used for identification purposes only.

County - The county in which the soil occurs (character). The county is not critical to the operation of WEPS and is used for identification purposes only.

Soil Survey Area Name - The soil survey area name in which the soil occurs (character). The soil survey area name is not critical to the operation of WEPS and is used for identification purposes only.

Soil Survey Area ID - The soil survey area identification for the soil (character). The soil survey area identification is not critical to the operation of WEPS and is used for identification purposes only.

Map Unit Symbol - The symbol used to uniquely identify the soil map unit in the soil survey (character). The map unit symbol is not critical to the operation of WEPS and is used for identification purposes only.

Component Name - The name of the soil (character). The soil component name is not critical to the operation of WEPS and is used for identification purposes only.

Component Percent - The percentage of the soil component of the map unit (integer). The soil component percent is not critical to the operation of WEPS and is used for identification purposes only.

Absolute range = >0 to 100 Typical range = >0 to 100

***Local Phase - Phase criterion to be used at the local level to help identify soil components (character). The local phase is not critical to the operation of WEPS and is used for identification purposes only.

Soil Order - The taxonomic soil order is the name for the highest level in soil taxonomy (character). The taxonomic soil order is not critical to the operation of WEPS and is used for identification purposes only.

***Soil Loss Tolerance (T factor) - The maximum amount of erosion at which the quality of a soil as a medium for plant growth can be maintained. (Tons/acre/year) The soil loss tolerance is not critical to the operation of WEPS and is used for identification purposes only.

Absolute range = 1 - 5 Typical range= 1 - 5

***Slope Gradient - The difference in elevation between two points, expressed as a percent of the distance between those points (%).

Absolute range = 0 - 100.0 Typical range= 0 - 30.0

Number of Layers - The number of soil layers used in the subregion. (integer)

Absolute range = 1 to100 Typical range = 1 to 5

Soil Surface Properties

Soil Crust

Soil Crust Thickness - Average thickness of the consolidated zone in the surface layer (mm).

Absolute range = (>0.01) to 23.0 Typical range = 0.0 to 10.0

Estimated by: 0.01

Soil Crust Density - The density of the soil crust (Mg/m^3).

Absolute range = 0.6 to 2.0 Typical range = 0.8 to 1.6
Estimated by: aggregate density

Soil Crust Stability - Mean of natural log of crust crushing energies (ln(J/kg))
Absolute range = 0.1 to 7.0 Typical range = 0.3 to 5.0
Estimated by: aggregate stability

Soil Crust Fraction - Fraction of surface covered with consolidated soil as opposed to aggregated soil (m^2/m^2).
Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: 0.0

Loose Material on Crust
Loose Material on Crust: Mass - Loose, saltation-size soil on the surface soil crusted area (kg/m^2).
Absolute range = 0.0 to 2.0 Typical range = 0.0 to 1.0
Estimated by: 0.0

Loose Material on Crust: Fraction - Fraction of total soil surface area covered with loose material on the crust (m^2/m^2).
Absolute range = 0.0 to soil crust fraction. Typical range = 0.0 to 0.5
Estimated by: 0.0

Roughness
Random Roughness - The standard deviation of heights of a random soil surface including any flat biomass adjusted as suggested by Allmaras (1966) (mm).
Absolute range = 1.0 to 30.0 Typical range = 2.0 to 10.0
Estimated by: 4.0

Ridge Orientation - Direction of the tillage ridge, clockwise from true north (degrees).
Absolute range = 0.0 to 179.0 Typical range = 0.0 to 179.0
Estimated by: 0.0

Ridge Height - The height of soil ridges from bottom of furrow to top of ridge (mm).
Absolute range = 0.0 to 500. Typical range = 0.0 to 300.0
Estimated by: 0.0

Roughness Spacing - Spacing between ridge tops (mm).
Absolute range = 10.0 to 2000.0 Typical range = 60.0 to 1000.0
Estimated by: 0.0

Ridge Width - Width of the top of the ridge (i.e. bed width) (mm)

Absolute range = 10.0 to 4000.0 Typical range = 100.0 to 2000.0
Estimated by: 0.0

Soil Albedo Dry - The estimated ratio of the incident short-wave (solar) radiation that is reflected by the air dry, less than 2 mm fraction of the soil surface (unitless).
Absolute range = 0.00 to 1.00 Typical range = 0.05 to 0.25
Estimated by: method of Post et.al. (2000) or method of Baumer (1990).

***Surface Fragment Cover - The fraction of the surface area covered by rock greater than 2.0 mm (m3/m3).
Absolute range = 0.0 to 1.0 Typical range = 0.0 - 0.5
Estimated by: Surface layer volume

Soil Layer Properties

Layer Number - The layer number.
Absolute range = 1 to 50 Typical range = 5 to 20
Estimated by: user defined

Thickness - The thickness of each soil layer (mm). WEPS requires a specific layer structure which is determined by the soil interface.
Estimated by: user defined

Sand - Mineral particles 0.05 to 2.0 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).
Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (silt + clay)]
Estimated by: sand = 1.0 - (silt + clay)

Silt - Mineral particles 0.002 to 0.05 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).
Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (sand + clay)]
Estimated by: silt = 1.0 - (sand + clay)

Clay - Mineral particles less than 0.002 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).
Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (sand + silt)]
Estimated by: clay = 1.0 - (silt + sand)

Rock Fragments - The volume fraction of rock greater than 2.0 mm (m3/m3).
Absolute range = 0.0 to 1.0 Typical range = 0.0 - 0.5
Estimated by: user defined

Sand Fractions

Sand Fractions: Coarse - Mineral particles 0.5 to 1.0 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0   Typical range = 0.0 to 1.0
Estimated by: user defined

Sand Fractions: Medium - Mineral particles 0.2 to 0.5 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0   Typical range = 0.0 to 1.0
Estimated by: user defined

Sand Fractions: Fine - Mineral particles 0.1 to 0.2 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0   Typical range = 0.0 to 1.0
Estimated by: user defined

Sand Fractions: Very Fine - Mineral particles 0.05 to 0.1 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0   Typical range = 0.0 to 1.0
Estimated by: user defined

Bulk Density

Bulk Density Dry - The oven dry weight of the less than 2 mm soil material per unit volume of soil exclusive of desication cracks, measured on a coated clod (Mg/m^3).

Absolute range = (>0.0) to 10.0   Typical range = 0.8 to 1.6
Estimated by: user defined

Bulk Density 1/3 Bar - The oven dry weight of the less than 2 mm soil material per unit volume of soil at a tension of 1/3 bar (Mg/m^3).

Absolute range = (>0.0) to 10.0   Typical range = 0.8 to 1.6
Estimated by: user defined

***Linear Extensibility Percent - The linear expression of the volume difference of natural soil fabric at 1/3 or 1/10 bar water content and oven dryness. (m^3/m^3)

Absolute range = 0.0 to 0.3   Typical range = ?
Estimated by: NRCS (1996)

Aggregate

Aggregate GMD - Soil aggregate geometric mean diameter of the modified log-normal distribution (mm).

Absolute range = 0.03 to 30.0   Typical range = 0.1 to 15.0

Aggregate GSD - Soil aggregate geometric standard deviation of the modified log-normal

distribution (dimensionless).
Absolute range = 1.0 to 20.0 Typical range = 4.0 to 15.0

Aggregate Max. Size - Upper limit of the modified log-normal aggregate size distribution (mm).
Absolute range = 1.0 to 1000.0 Typical range = 2.0 to 100.0

Aggregate Min. Size - Lower limit of the modified log-normal aggregate size distribution (mm).
Absolute range = 0.001 to 5.0 Typical range = 0.006 to 0.020

Aggregate Density - The aggregate density for (Mg/m^3).
Absolute range = 0.6 to 2.5 Typical range = 0.8 to 2.0

Aggregate Stability - Mean of natural log of aggregate crushing energies (ln(J/kg))
Absolute range = 0.1 to 7.0 Typical range = 0.5 to 5.0

Water Content

Water Content: Initial - Soil water content at the beginning of the simulation (kg/kg).
Absolute range = 0.005 to 0.440 Typical range = varies with soil texture

Water Content: Saturation - Soil water content when soil pores are completely filled (i.e. zero soil matric potential) (kg/kg).
Absolute range = 0.208 to 0.440 Typical range = varies with soil texture
Note: Saturated water content > Field capacity water content > Wilting point water content

Water Content: Field Capacity (1/3 bar) - The amount of soil water retained at 1/3 bar (33 kPa), expressed as a fraction of the less than 2 mm, oven dry soil by weight (kg/kg).
Absolute range = 0.012 to 0.335 Typical range = varies with soil texture
Note: Saturated water content > Field capacity water content > Wilting point water content

Water Content: Wilting Point (15 bar) - The amount of soil water retained at 15 bars (1500 kPa), expressed as a percentage of the less than 2 mm, oven-dry soil by weight (kg/kg).
Absolute range = 0.005 to 0.242 Typical range = varies with soil texture
Note: Saturated water content > Field capacity water content > Wilting point water content

????Water Content: 1/10 bar - The amount of soil water retained at 1/10 bar (10 kPa), expressed as a fraction of the less than 2 mm, oven dry soil by weight (kg/kg).

????CB - The power of Campbell's model of the soil water characteristics curve (unitless).
Absolute range = 0.917 to 27.027 Typical range = varies with soil texture

Air Entry Pot. - The air entry potential is defined as the potential at which the largest water-filled pores start to drain and hence gas flow can be observed (Joules/kg).
Absolute range = -17.91 to 0.0 Typical range = varies with soil texture

Sat. Hydraulic Conductivity - The amount of water that would move vertically through a unit area of saturated soil in a unit time under unit hydraulic gradient (m/s).
Absolute range = 0.0 to 1E-3 Typical range = 0.0 to 1E-3

Other Layer Properties
Organic Matter - The amount by weight of decomposed plant and animal residue expressed as a weight fraction of the less than 2 mm soil material (kg/kg).
Absolute range = 0.0 to 0.1 Typical range = 0.0005 to 0.05

pH - The negative logarithm to the base 10, of the hydrogen ion activity in the soil using 1:1 soil:water ratio method (unitless). A numerical expression of the relative acidity or alkalinity of a soil sample.
Absolute range = 1.0 to 14.0 Typical range = 4.0 to 9.0

CaCO3 - The quantity of carbonate (CO3) in the soil expressed as CaCO3 and as a weight percentage of the less than 2 mm size fraction (kg/kg).
Absolute range = 0.0 to 1.0 Typical range = 0.0 to 0.3

CEC - The cation exchange capacity (meq/100g).
Absolute range = 0.0 to 400.0 Typical range = 0 to ?

Figure 24 Example Soil File.

```
Soil ID KS181-KUU-Kuma-100-SIL-Kansas-Sherman County-Sherman County, Kansas
# Taxorder
Mollisols
# number of soil layers
3
# Layer thickness (mm)
130    610    780
# Sand fraction
0.113    0.073    0.114
# Silt fraction
0.677    0.662    0.686
# Clay fraction
0.210    0.265    0.200
# Rock fragments
```

```
0.020    0.020    0.040
# Sand fraction coarse
0.000    0.000    0.000
# Sand fraction medium
0.009    0.007    0.009
# Sand fraction fine
0.033    0.022    0.034
# Sand fraction very fine
0.066    0.038    0.066
# Water dispersible clay
0.000    0.000    0.000
# Bulk Density (dry)
1.310    1.490    1.520
# Bulk Density (1/3 bar)
1.250    1.300    1.450
# Aggregate geometric mean diameter for layer
0.030    17.562   26.157
# Aggregate geometric standard deviation for layer
1.000    13.917   11.730
# Maximum aggregate size for layer
1.000    53.043   62.079
# Minimum aggregate size for layer
0.010    0.010    0.010
# Aggregate density for layer
1.688    2.000    2.000
# Aggregate stability for layer
3.077    3.319    3.018
# Soil crust thickness (mm)
0.010
# Soil crust density
1.688
# Soil crust stability
3.08
# Soil crust surface fraction
0.00
# Loose material on crust (kg)
0.00
# Fraction of loose material on crust
0.00
# Random roughness
4.00
# Ridge orientation
0.00
# Ridge height
0.00
# Spacing between ridge tops
0.00
# Ridge width
0.00
# Initial soil water content for layer
0.212    0.228    0.197
# Saturation soil water content for layer
0.394    0.391    0.338
# Field capacity water content for layer
0.286    0.300    0.273
# Wilting point water content for layer
```

```
0.138    0.157    0.121
# 0.1 Bar on Sand Soil
-999.000    -999.000    -999.000
# Soil CB value for layer
4.212    4.748    4.119
# Air entry potential for layer
-4.544    -4.224    -4.686
# Saturated hydraulic conductivity for layer
9.0E-6    9.0E-6    9.0E-6
# curve number---good
0.00
# curve number---poor
0.00
# Dry soil albedo
0.230
# Organic matter for layer
0.030    0.018    0.005
# Soil PH for layer
7.30    7.50    8.50
# Calcium carbonate equivalent for layer(CaCO3)
0.50    0.03    0.08
# Cation exchange capacity for layer
12.50    15.00    11.50
# Sum of bases for layer
0.00    0.00    0.00
# Electrical Conductivity
0.00    0.00    0.00
# Sodium Adsorption Ratio
0.00    0.00    0.00
# Available nitrogen for layer
0.00    0.00    0.00
# Available phosphorus for layer
0.00    0.00    0.00
```

Management File

The default file name is '*.man'. This file contains parameters for the manipulation of soil and biomass properties as a result of various management operations performed on the field on a given date. These operations include planting, harvesting, cultivation, defoliation, fertilization, and irrigation. The management file should only be altered using the Management Crop Rotation Editor for WEPS (MCREW) to guarantee that parameters are correct. MCREW is accessed through the WEPS user interface.

Stand Alone Erosion Submodel

The Erosion submodel can also be operated as a stand alone model to simulate erosion for a single storm (i.e., daily). Input parameters which must be provided for the day include the field and barrier dimensions as well as biomass, soil, hydrology, and weather parameters. Wind speed can be entered either as Weibull distribution parameters or listed as average wind speeds for each time period throughout the day. This file contains comments (indicated by a '#' in column one) which describes each line of input data to aid in checking and modifying input data. Specific definitions of these parameters are documented within the input file. Command line options are as follows:

Valid command line options:

-? or -h	display this help screen
-x#	number grid points in x direction
-y#	number grid points in y direction
-t#	surface updating interval (seconds)
-u	disable erosion surface updating
-i"input_filename"	specify input filename
<"input_filename"	specify input filename
>"output_filename"	specify output filename (default is to print to screen)
-E	erosion summary (kg/m^2)
	total salt/creep susp PM10 filename
-Plot	enable printing of Hagen plot file

Figure 5.25. Example stand alone erosion input file.

```
# Input file for the erosion standalone model.
#
# All lines beginning with a "#" character are comment lines
# and are skipped.
#
# +++DEBUG FLAGS +++
#   Debug flag for providing different levels of debug information
#        value of 0 will print no debug information
#        value of 1 will print out and number all input lines
#        value of 2 will print out and number all DATA input lines
#        value of 3 will do both 1 and 2
 0
#      EROSION initialization flag
 .TRUE.
#      EROSION "print" flag
 1
#
# +++ SIMULATION REGION +++
#
#      Simulation region diagonal coordinates (meters)
#       specify in this form: x1,y1  x2,y2
 0.0,  0.0  180.0,  180.0
#      Simulation region orientation angle (degrees from North)
 0.0
#      Number of accounting regions (must be 1)
 1
#
# +++ ACCOUNTING REGIONS +++
#
#      Accounting region diagonal coordinates (meters)
#       specify in this form: x1,y1  x2,y2
 0.0, 0.0  180.0, 180.0
#
# +++ BARRIERS +++
```

```
#
#      Number of barriers (0-5)
 0
#      Barrier diagonal coordinates (meters)
#       specify in this form: x1,y1  x2,y2
# 0.0, 0.0  0.0  100.0
#      Barrier height (meters), porosity (m2/m2), width (meters)
# 1.2 0.50 2.0
#      Repeat the above two input lines for each barrier
#
# +++ SUBREGION REGIONS +++
#
#      Number of subregions (must be 1)
 1
#      Subregion diagonal coordinates (meters)
#       specify in this form: x1,y1  x2,y2
 0.0, 0.0  180.0, 180.0
#
# +++ BIOMASS +++
#
#      Height of standing biomass (meters)
 0.0
#      Stem area index (m2/m2), leaf area index (m2/m2)
#       both refer to STANDING biomass only
 0.0  0.0
#      Crop row spacing (meters), 0.0=broadcast; plant location (0=furrow,1=ridge)
 0.0, 0
#      Flat biomass cover (m2/m2)
 0.04
#
# +++ SOIL +++
#
#      Number of soil layers (3-10)
 3
#      The following soil inputs are repeated for each layer
#
#      layer thickness (mm)
 10.0  40.0 200.0
#      bulk density (g/cm3)
 1.4   1.4  1.4
#      sand content, 0.05-2.0 mm (kg/kg)
 0.83  0.83 0.83
#      very fine sand, 0.05-0.1 mm (kg/kg)
 0.20  0.20 0.20
#      silt content (kg/kg)
 0.09  0.09 0.09
#      clay content (kg/kg)
 0.08  0.08 0.08
#      rock volume (m3/m3)
 0.0   0.0  0.0
#      aggregate density (g/cm3)
 1.8   1.8  1.8
#      aggregate stability (ln[J/kg])
 1.93  2.65 2.65
#      The next 4 parameters define the aggregate size
#        distribution for each layer.
#        aggregate geometric mean diameter (mm)
 0.28  0.98 0.98
#        minimum aggregate size (mm)
 0.001 0.01 0.01
#        maximum aggregate size (mm)
 14.9  48.8 48.8
```

```
#        aggregate geometric standard deviation (mm/mm)
 25.4  20.4 20.4
#      The next six variableas are surface crust variables
#        for each layer.
#        fraction of soil surface that is crusted (m2/m2)
#        crust (consolidated zone) thickness (mm)
#        fraction of crusted surface covered by loose material (m2/m2)
#        mass of loose material on crusted surface (kg/m2)
#        crust density (g/cm3)
#        crust stability (ln[J/kg])
 0.5   3.51  0.29  0.255   1.2   1.93
#      Allmaras random roughness (mm)
 1.7
#      The next four variables are ridge variables for each layer.
#       Ridge height (mm)
#       Ridge spacing (mm)
#       Ridge width (mm)
#       Ridge orientation (degrees from North)
 20.0  1016.0    0.0   90.0
#      Dike spacing (mm)
 0.0
#      Snow depth (mm)
 0.0
#
# +++ SOIL WATER +++
#
#      Soil layer wilting point water content (kg/kg)
 0.05  0.05  0.05
#      Soil layer water content (kg/kg)
 0.01  0.05  0.05
#      HOURLY soil water content at soil surface (kg/kg)
#       two lines, with 12 values on each line
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
#
# +++ WEATHER +++
#
#      Air density (g/cm3)
 1.2
#      Wind direction (deg)
 286.0
#      Number of intervals/day, maximum = 96
 48
#      Information about the anemometer
#       anemometer height (meters)
#       aerodynamic roughness at anemometer site (mm)
#       anemometer location flag (0 - away from field, 1 - on field)
 2.0   25.0    1
#      Wind/Weibull flag (0 -use Weibull parameters, 1 -use wind speeds)
 0
#      Wind statistics. These parameters are used only when the Wind/Weibull flag = 0
#       Fraction of time that winds are calm (hr/hr)
#       Weibull "c" factor (m/s)
#       Weibull "k" factor
 0.217  7.125  2.971
#      Wind speeds (m/s).  The wind data are used only when the Wind/Weibull flag = 1
#       Must have as many wind speeds as number of intervals/day.
#       Must have 6 values per line.
#       Wind data should be AVERAGES for the period.
#       Hourly averages will likely underestimate wind erosion somewhat.
#       30-min averages or shorter is more suitable (As is done here).
#    0.00    0.00    0.00    0.00    0.00    1.19
```

```
#    2.76    3.47    4.00    4.44    4.84    5.20
#    5.54    5.87    6.20    6.53    6.86    7.20
#    7.56    7.95    8.39    8.91    9.57   10.64
#   11.86   10.02    9.21    8.64    8.16    7.75
#    7.38    7.03    6.69    6.36    6.04    5.71
#    5.37    5.02    4.64    4.23    3.75    3.15
#    2.24    0.00    0.00    0.00    0.00    0.00
#
# +++ VARIABLES TO WRITE TO 'PLOT.OUT' +++
#
#      Flag for writing variables to 'plot.out'.
#       -1 = write nothing
#        0 = write erosion variables;
#      Write variables below if flagged with a 1
 0
#
#      Next are 2 lines per variable:
#       1st line: flag (0=don't write, 1=do write) and variable description
#       2nd line: this info is used as a header in 'plot.out'
#           place header within first 12 positions of the line
#
#      Field length (m)
0
   length(m)
#      biomass height(m)
1
   bio_ht(m)
#      Stem area index (m2/m2)
1
   stem_area
#      Biomass leaf area index (m2/m2)
1
   lai_area
#      Biomass flat fraction cover (m2/m2)
0
   flat_cov
#      Soil fraction very fine sand in layer 1 (kg/kg)
0
   vfsand
#      Soil fraction sand in layer 1 (kg/kg)
0
    sand
#      Soil fraction silt in layer 1 (kg/kg)
0
    silt
#      Soil fraction clay in layer 1  (kg/kg)
0
    clay
#      Soil volume rock in layer 1(m3/m3)
0
  rock_vol
#      Soil aggregate stability (ln[J/kg])
0
   ag_stab
#      Aggregate geometric mean diameter (mm)
0
   ag_gmd
#      Minimum aggregate size (mm)
0
   ag_min
#      Maximum aggregate size (mm)
0
```

```
    ag_max
#      Aggregate geometric standard deviation (mm/mm)
0
    ag_std
#      Fraction of soil surface that is crusted (m2/m2)
0
    crust_cv
#      Crust (consolidated zone) thickness (mm)
0
  crust_z(mm)
#      Faction of crusted surface covered by loose material (m2/m2)
0
    los_cv
#      Mss of loose material on crusted surface (kg/m2)
0
  los(kg/m2)
#      Crust density (g/cm3)
0
    cr_den
#      Crust stability (ln[J/kg])
0
    cr_se
#      Allmaras random roughness (mm)
0
    rr(mm)
#      Ridge height (mm)
0
  z_rgh(mm)
#      Ridge spacing (mm)
0
  x_rgs(mm)
#      Ridge width (mm)
0
  x_rgw(mm)
#      Ridge orientation (degrees from North)
0
  a_rgo(deg)
```

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“HOW TO” GUIDES

WEPS How To Guide

Barriers

Wind barriers in WEPS include any structure designed to reduce the wind speed on the downwind side of the barrier. They also trap moving soil. Barriers include but are not limited to, linear plantings of single or multiple rows of trees, shrubs, or grasses established for wind erosion control, crop protection, and snow management. Snow fences, board walls, bamboo and willow fences, earthen banks, hand-inserted straw rows, and rock walls have also been used as barriers for wind erosion control in limited situations. Barriers also reduce evapotranspiration, shelter livestock, and provide wildlife habitat. One advantage of barriers over most other types of wind erosion control is they are relatively permanent. During drought years, barriers may be the only effective and persistent control measure on crop land. Barriers primarily alter the effect of the wind force on the soil surface by reducing wind speed on the downwind side of the barrier but also reduce wind speed to a lesser extent upwind of the barrier (Fig 6.1).

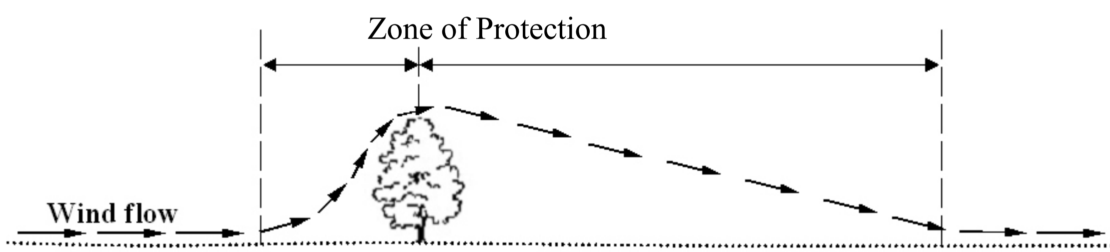

Figure 6.1. Diagram showing wind flow pattern over a barrier.

Research has shown that barriers significantly reduce wind speed downwind, sheltering a portion of the field from erosion and in effect, reducing the field length along the erosive wind direction. However, the protected zone of any barrier diminishes as porosity increases and is reduced significantly when barrier porosity exceed 60 percent. Protection is also reduced as wind velocity increases but the protected area diminishes as the wind direction deviates from the perpendicular to the barrier. Various types of barriers are used for wind erosion control in WEPS 1.0. The WEPS interface provides a method of selecting from a list of barriers to place on the field and editing the barrier properties. The user can also modify properties in the barrier database that appear in the drop down list. Each of these properties are described below.

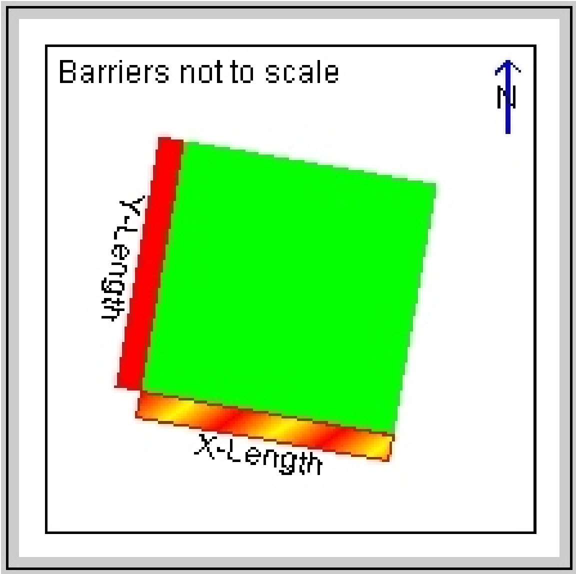

Figure 6.2. Field View Panel.

Adding and Removing Barriers Using the Interface

The Field View Panel (Fig. 6.2), located in the center of the WEPS1.0 main screen, is designed to give the user a view of the field size, shape, and orientation (green). The placement of any barriers present is displayed in red. Note that if the ratio of actual length to width of the field or barriers is too great to display to scale, this will be indicated within the panel and an approximation of the field or barrier shape will be displayed. This panel is for viewing only and is not editable.

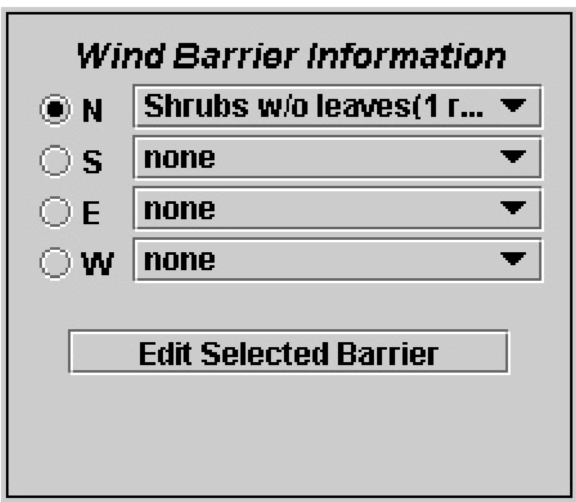

Figure 6.3. Simulation Run Information Panel.

The wind barrier panel (Fig. 6.3) is used to add barriers to the field. Note that WEPS1.0 only allows barriers on the borders of the field. The barrier location for each field border is labeled 'N' for north, 'S' for south, 'E' for east, and 'W' for west. The barrier type can be selected from the drop down list in the panel by clicking the down arrow to the right of the barrier type to bring up the list of available barriers and then clicking on the appropriate barrier. Once a barrier type is selected, the barrier properties may be viewed and edited by clicking the 'Edit Selected Barrier' button at the bottom of the panel. A separate panel opens where the user may change the default barrier width, height, and porosity values in the appropriate fields. The modified barrier parameters are stored with the project. If a barrier other than 'None' is selected, the 'Edit Selected Barrier' button will open the properties panel only if the radio button is clicked on for that barrier. To remove a barrier from the field, click the radio button to select it (notice the barrier in the View Panel will be 'highlighted' when selected) then select the barrier type 'None', to remove it.

Edit Selected Barrier

To view and edit the properties of a barrier, click the radio button for the corresponding barrier , then click the ‘Edit Selected Barrier’ button. A window will open displaying the properties shown below. If properties are modified by the user through the interface, the barrier type will display ‘<mod>’ in front of the barrier type name.

The length of a barrier is defined by field length along the border on the barrier is placed.

Width The width of a barrier is defined as the distance from one side of the barrier to the other, in the units of measure displayed on the screen (feet or meters) (Fig. 6.4). For a single row wind barrier, the width is equal to the diameter of the tree, shrub, or grass, or for artificial barriers, the thickness of the material (e.g. slat fence). This is illustrated as “a” in Fig. 6.4. For multiple row barriers, the width is the distance from one side of the barrier to the other as illustrated by “b” in Fig. 6.4.

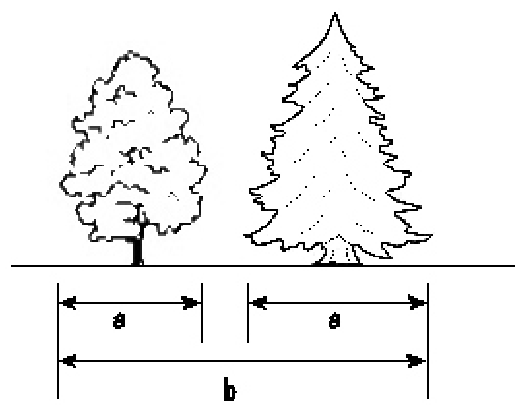

Figure 6.4. Barrier width for single (a) and multiple (b) row barriers.

Height The height of a barrier is the average height of individual elements (e.g. trees) in the barrier (“a” in Fig. 6.15, 5 for single row barriers). The units of measure for barrier height are displayed on the input screen in feet or meters. For multiple row barriers, use the height of the tallest barrier row (‘b” in Fig. 6.15, 5).

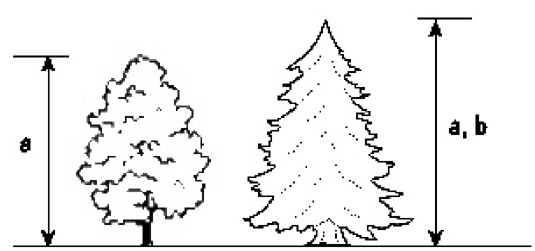

Figure 6.5. Barrier height for single (a) and multiple (b) row barriers.

Area The area of the barrier is calculated from the barrier width and length (i.e., barrier width x field length). This is not an editable item, but is calculated within WEPS 1.0.

Porosity Barrier porosity is defined as the total optical porosity of all rows in the barrier. It is the open space (i.e., absence of leaves and stems) as viewed looking perpendicular to the barrier, expressed as a percent of the total area (ie., (1.0 - silhouette area) x 100). WEPS 1.0 does not "grow" living barriers. They do not increase or decrease porosity with leaf growth and leaf drop (senescence), nor do they increase in size from one year to the next. As such, the porosity of barriers in WEPS does not change with the seasons nor from year to year. Therefore the user should input the porosity of the barrier that is present when the erosion hazard is the greatest. Figure 6.17, 6 illustrates the effect of porosity on the near surface wind speed relative to an open field without a barrier.

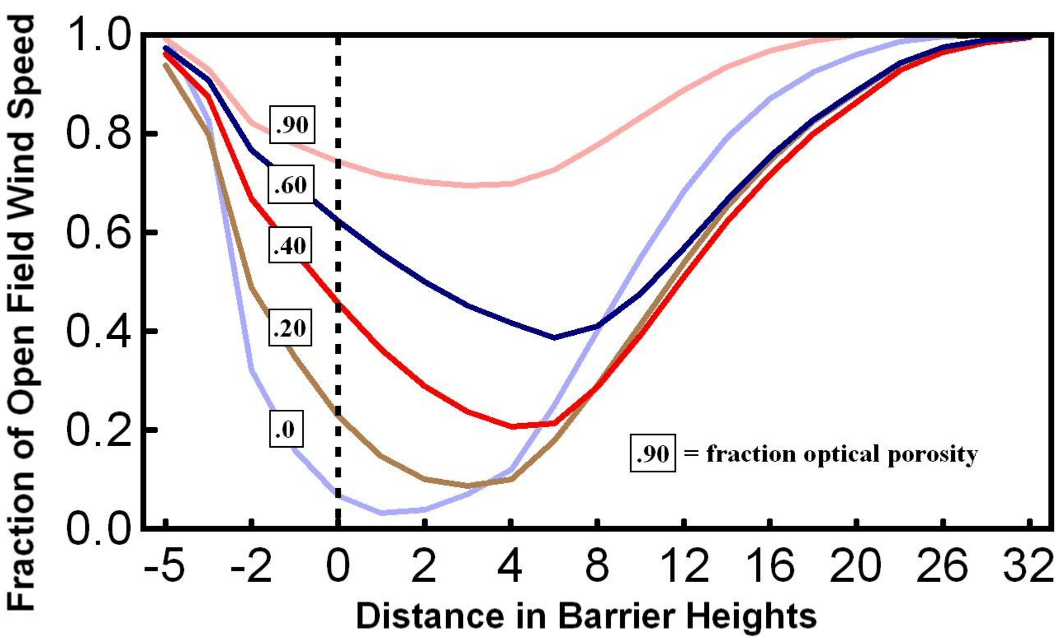

Figure 6.6. Effect of the fraction of optical porosity on near surface wind speed along the wind direction relative to barrier.

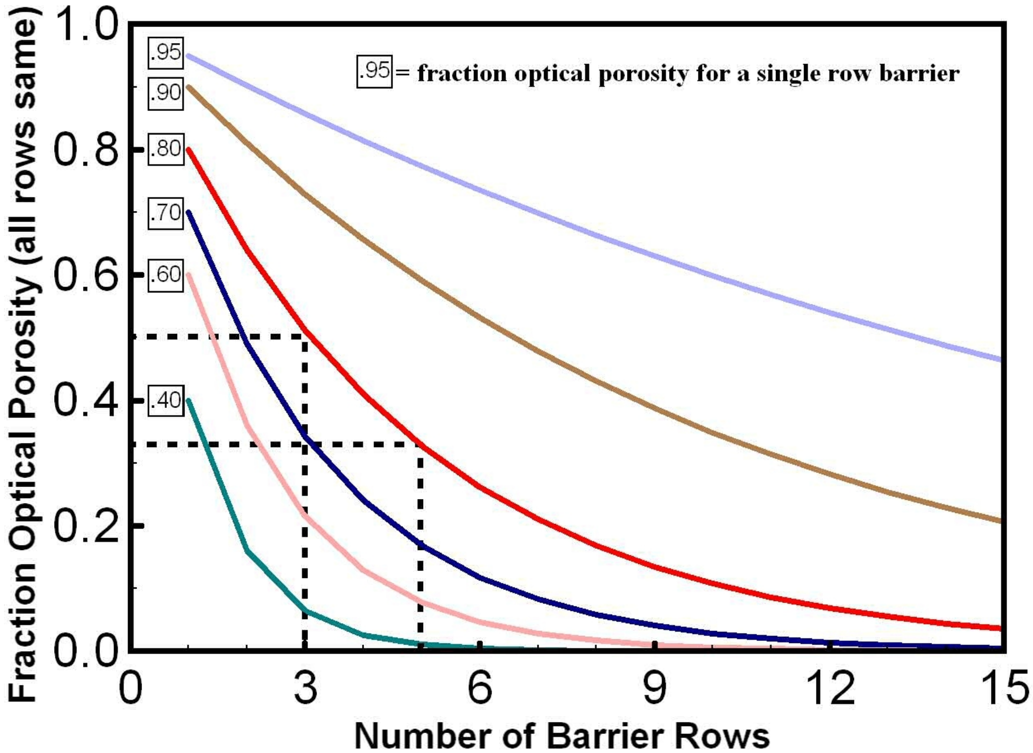

Figure 6.7. Effect of number of barrier rows on optical porosity where all barrier rows are the same.

At times, it is most efficient to estimate optical porosity for a single row, particularly for crop barriers. Then for multiple row barriers, the optical porosity decreases for the entire barrier as illustrated in Figure 6.7. For example, a single row of corn has an optical porosity of 0.80. Three rows of corn have an optical porosity of 0.50 while five rows of corn have an optical porosity of 0.33.

The following graphic illustrations (Figs 6.8 - 6.10) can be used as a guide to determine optical porosity for single row barriers in the field.

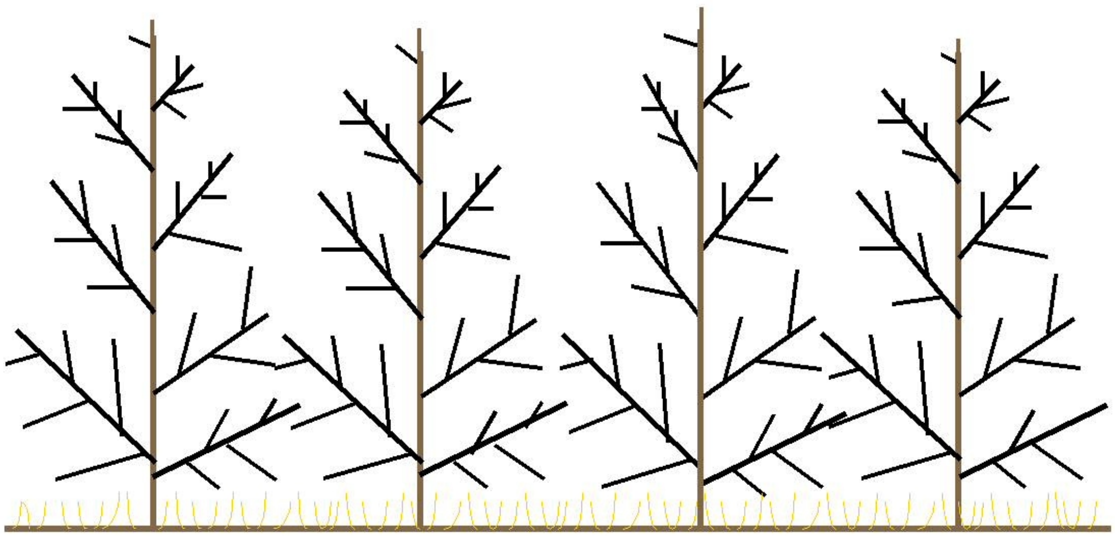

Figure 6.8. Graphic illustration of a barrier with an optical porosity of ?.??.

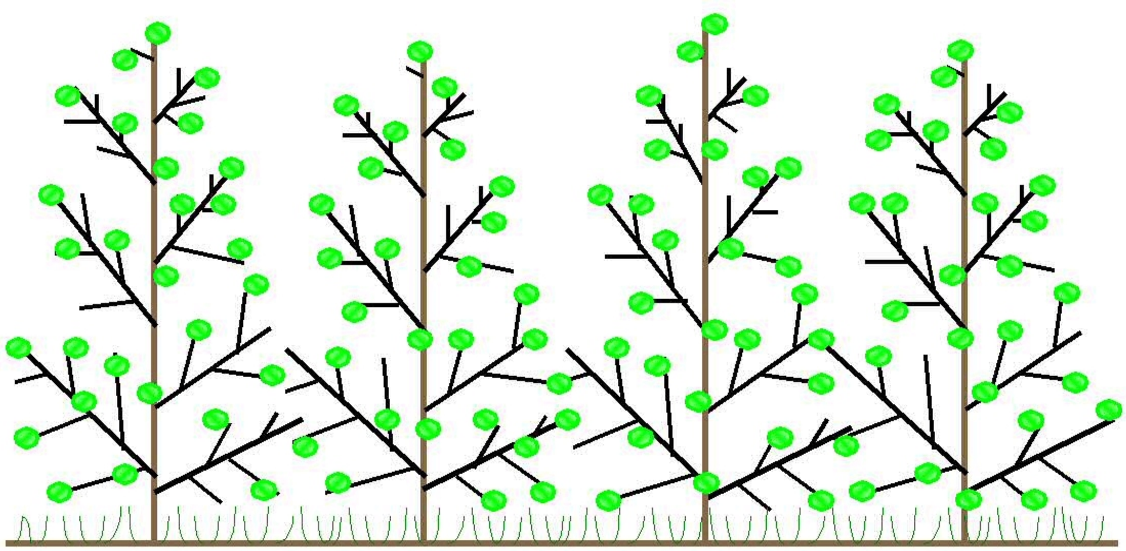

Figure 6.9. Graphic illustration of a barrier with an optical porosity of ?.??.

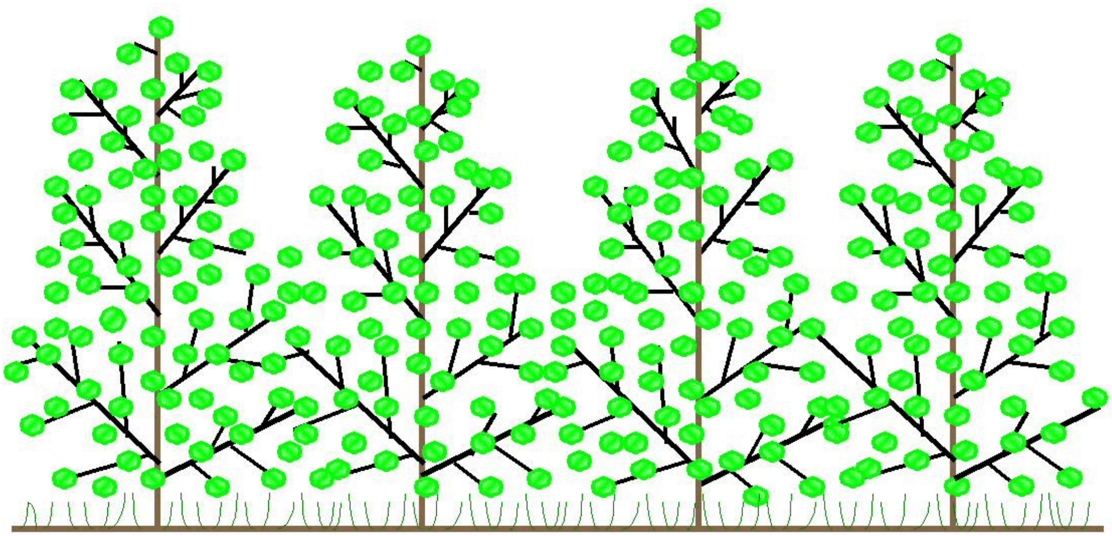

Figure 6.10. Graphic illustration of a barrier with an optical porosity of ?.??.

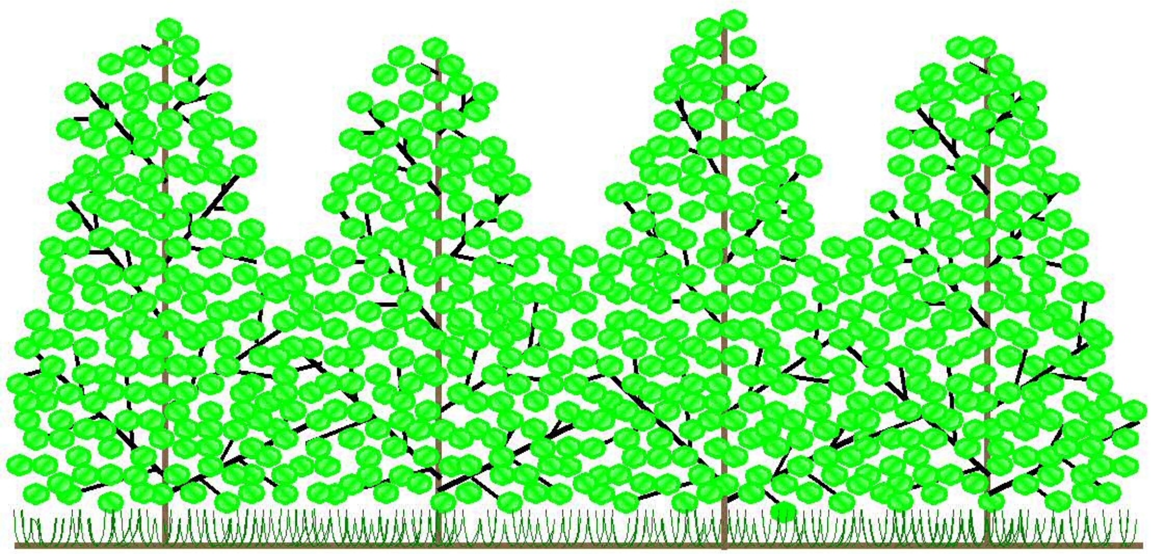

Figure 6.11. Graphic illustration of a barrier with an optical porosity of ?.??.

Barrier Property Database

Default barrier properties specified in the barrier property database cannot be permanently changed through the WEPS interface. But they can be modified and stored with the current project. Barrier properties may however, be modified in the barrier database file. Figure 6.12 shows the barrier database file, ‘barrier.dat’, which is located in the “WEPS1.0 Install” directory. This ascii file may be edited (for NRCS only by designated qualified agronomists), using a standard text editor to add new barriers or modify parameters of existing barriers. The file separates barriers into various categories (i.e., TREES, SHRUBS, HERBACEOUS, etc.). However the user interface does not read nor display these barrier categories and they only serve as a visual aid within the database. Actual database values are in rows which begin with a blank in column one and each database parameter is separated by the pipe symbol, ‘|’. The parameters are listed as follows: barrier name | height (meters) | number of rows (not used) | porosity | width (meters). Barrier height, width, and porosity were defined previously in this document. The barrier name is a character descriptor of the barrier. The number of barrier rows parameter is not currently used by WEPS nor is it displayed in the interface. Once the barrier database file has been updated, restart WEPS and the new barrier or parameters should appear in the barrier drop down list on the WEPS user interface.

Figure 6.12. Barrier database file “barrier.dat”.

```
TREES
 Trees w/o leaves(1 row)|8|1|0.8|3
 Trees w/o leaves(2 row)|8|2|0.7|7
 Trees w/o leaves(4 row)|8|4|0.6|15
 Trees w/ leaves(1 row)|8|1|0.6|3
 Trees w/ leaves(2 row)|8|2|0.5|7
 Trees w/ leaves(4 row)|8|4|0.4|15
SHRUBS
 Shrubs w/o leaves(1 row)|2|1|0.7|2
 Shrubs w/o leaves(2 row)|2|2|0.5|5
 Shrubs w/ leaves(1 row)|2|1|0.5|2
 Shrubs w/ leaves(2 row)|2|2|0.3|5
HERBACEOUS
 Grass Barrier(1 row)|0.8|1|0.7|0.5
 Grass Barrier(2 row)|0.8|2|0.5|1.0
CROP
 Kenaf(1 row)|2.5|1|0.7|1
 Kenaf(2 row)|2.5|2|0.5|2
 Sorghum(1 row)|2|1|0.7|1
 Sorghum(2 row)|2|2|0.5|2
 Flax(1 row)|0.5|1|0.7|0.5
 Flax(2 row)|0.5|2|0.5|1
 Corn(2 row)|1.5|2|0.7|2
 Corn(3 row)|1.5|2|0.6|3
 Corn(4 row)|1.5|2|0.5|4
 Wheat/Rye(1 row)|0.8|1|0.7|0.5
 Wheat/Rye(2 row)|0.8|2|0.6|0.6
 Wheat/Rye(3 row)|0.8|3|0.6|0.8
 Wheat/Rye(4 row)|0.8|4|0.5|1.0
 Wheat/Rye(1 row)|0.8|4|0.5|1.0
ARTIFICIAL
 Snow fence|1.2|1|0.6|1
 Solid fence|2|1|0.05|1
```